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The Canadian Entomologist

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Species of *Acoma* Casey Having a Three-segmented Antennal Club (Coleoptera: Scarabaeidae)[1]

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Cazier (1953, pp. 1-13) listed six species of *Acoma* having three-segmented antennal clubs. Though some of these species are easily distinguished, Cazier noted that others vary considerably. Since Cazier's revision, additional material has become available that makes further consideration of this group of *Acoma* worthwhile. In this paper, a key to the species having a three-segmented antennal club is given, the six known species are redescribed, and nine new species are described.

In this study it soon became evident that any series of one species taken in a restricted locality was rather constant in color, punctures, sculpture, and pilosity. Almost all of the specimens were taken at light, and all known specimens are males. Because of the lack of females, Van Dyke (1928, p. 157) and Cazier (1953, p. 2) considered the females to be flightless. The variability in series taken from different localities coupled with the uniformity in specimens from a single locality would seem to substantiate this idea of flightless females. In the genus *Pleocoma*, in which the females are known to be flightless, numerous small, restricted, but distinct populations are found. Until further information is obtained, it seems best to treat the genus *Acoma* much as *Pleocoma* was treated by Linsley (1938) and *Podolasia* by Howden (1954).

The phylogenetic placement of the genus has been discussed by Van Dyke (1928), Davis (1935), and Cazier (1953), but is likely to remain in doubt until information on the morphology of the female becomes available.

Acknowledgments

The generous loan of specimens from numerous institutions and individuals made this work possible. In the following list of collections studied, the letters in parentheses represent the abbreviations used in the text in citing the material studied and the name of the curator responsible for the loan of specimens follows the abbreviation: American Museum of Natural History (AMNH), New York Dr. Mont A. Cazier and Mrs. P. Vaurie; California Academy of Sciences (CAS), San Francisco, Mr. H. B. Leech; Cornell University (CU), Ithaca, Dr. Henry Dietrich; Ohio State University (OSU), Columbus, Dr. J. N. Knull; United States National Museum (USNM), Washington, D.C., Mr. O. L. Cartwright; University of Arizona (UA), Tucson, Dr. Floyd Werner; University of Kansas (UK), Lawrence, Dr. G. W. Byers. The abbreviation "CNC" represents the Canadian National Collection. Mr. L. J. Bottimer, Kerrville, Texas, and Mr. Frank H. Parker, Globe, Arizona, generously loaned specimens from their personal collections.

I am also indebted to my colleagues Mr. W. J. Brown and Dr. E. C. Becker for their assistance in checking the key and criticizing the manuscript.

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2 Entomologist.

Characters

In the present work a number of characters were used in establishing the specific limits. Although difficult to describe, the irregular, rugose punctures or granulations of the frons and vertex, the shape of the clypeus, and the shapes of the carinae above the eyes all seem moderately similar within the various populations and are useful in distinguishing some of the species. Cazier (1953, pp. 1-2) states, "The antennae appear to be the most plastic and definite of all the characters and as a result have a wide range of variability generically". The club is composed of three to seven segments in the genus. Though this paper is concerned with only the group having a three-segmented club, the antennal funicle likewise shows variation that appears to be useful for separating the species. However, the characters of the funicle are not always constant and can be relied on only in a series of specimens. The labrum and mandibles are very useful as an aid in determining some of the specific relationships. The labrum is large in some species, conical, flattened, or transverse, or sometimes nearly invisible. The mandible differs in size, shape, number of setae on the outer face, and in the presence or absence of teeth of the scissorial and molar regions. Unfortunately, the mandibular characters have a limited usefulness as the tips and the scissorial and molar regions are often considerably abraded. The shape of the prosternum is sometimes useful. The spines on the middle and hind tibiae likewise occasionally show differences and are particularly useful in separating the *confusa* group from related species. Though generally similar, the male genitalia, when viewed laterally, differ in the shape of the tip, amount of curvature, and size.

The following summary of the various groups or complexes of *Acoma* having three-segmented antennal clubs supplements the subsequent key.

***glabrata* group**

Two species: *glabrata, nigrita.*

Range: Upper Baja California, southern California, and extreme southwestern Arizona.

Characters: Antenna with ten segments rather than nine (sixth and seventh segments occasionally fused); setae absent on elytral disc.

***arizonica* group**

Two species: *arizonica, mixta.*

Range: Southwestern half of Arizona.

Characters: Setae on disc of elytra short, usually no longer than the width of the intervals. Color tan to light brown.

***confusa* group**

Four species: *confusa, incognita, parva, ochlera.*

Range: Baja California.

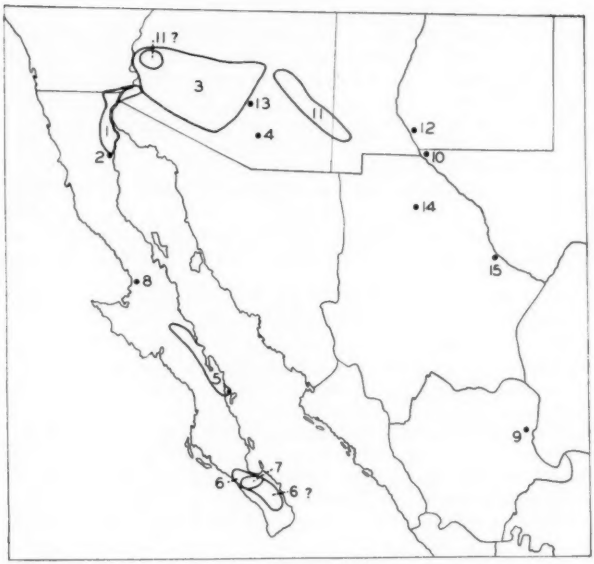
Characters: Elongate; dark reddish-brown with long, conspicuous setae on elytral disc; occasional setae often present on pronotal disc; punctures and rugae of frons shallow; sixth segment of funicle triangular in outline, fifth segment elongate. Male genitalia very similar and not reliable for separating the species within the group. Three of the species have the lateral margin of pronotum sinuate just behind the anterior angles.

***granulifrons* group**

One species: *granulifrons.*

Range: Durango, Mexico.

Characters: Frons granulate, with two faint tubercles at anterior edge of vertex between the eyes. Color brownish-black. In some ways, intermediate



Explanation of Map

Distributions of species of *Acoma* having a three-segmented antennal club:
1, *Acoma glabrata* Cazier; 2, *A. nigrita* Cazier; 3, *A. arizonica* Brown; 4, *A. mixta* n. sp.; 5, *A. confusa* Van Dyke; 6, *A. incognita* n. sp.; 7, *A. parva* n. sp.; 8, *A. ochlera* n. sp.; 9, *A. granulifrons* n. sp.; 10, *A. brunnea* Casey; 11, *A. knulli* n. sp.; 12, *A. diminiata* n. sp.; 13, *A. rufula* n. sp.; 14, *A. minuta* Cazier; 15, *A. seticollis* n. sp.

between the *confusa* and *brunnea* groups. The head, with the ridges over the eyes, similar to that of *confusa*, but the antennae and genitalia approach some of those found in the *brunnea* group.

***brunnea* group**

Four species: *brunnea, knulli, diminiata, rufula.*

Range: Extreme western Texas, southern New Mexico, and southern Arizona.

Characters: An extremely variable group with color ranging from tan to dark brownish-black. Frons usually heavily, irregularly punctuate; ridge above eyes poorly developed and not extending to base of clypeus. Elytral striae usually fairly well developed, with long, conspicuous setae in the elytral intervals. Sixth antennal segment oval to disc-shaped.

***minuta* group**

Two species: *minuta, seticollis.*

Range: Northern Chihuahua, Mexico.

Characters: Size small to moderate; sixth segment of antennal funicle nearly globular; disc of pronotum with several to numerous long, conspicuous setae. The presence of setae on the pronotal disc nearly unique, being found elsewhere only in the unrelated *confusa* group.

Key to Species of *Acoma*
Having a Three-segmented Antennal Club

1. Elytra lacking hairs except along margins, antennae normally 10-segmented **2**
   Elytra with at least some short hairs on disc, antennae 9-segmented **3**

2. Color black; elytral striae deeply impressed, Baja California ..... *nigrita* Cazier
   Color pale reddish-brown; elytral striae shallowly impressed. Baja California; southern California; vicinity of Yuma, Arizona ..... *glabrata* Cazier
3. Anterior lateral margins of pronotum straight or arcuate; anterior angles usually obtuse or nearly so (Fig. 13) 6
   Anterior lateral margins of pronotum slightly sinuate; anterior angles acute and slightly extended near eyes (Fig. 12), Baja California 4
4. Clypeus rounded, truncate, or slightly emarginate 5
   Clypeus distinctly emarginate, often bidentate. Loreto to San Ignacio, Baja California ..... *confusa* Van Dyke
5. Clypeus deeply reflexed; clypeal disc with moderate-sized punctures separated by approximately one diameter. Size over 5 mm. Venancio to Santiago, Baja California ..... *incognita* n. sp.
   Clypeus shallowly reflexed; clypeal disc with large, nearly confluent punctures. Size under 5 mm. West of La Paz, Baja California ..... *parva* n. sp.
6. Hairs on elytral disc conspicuous, at least some as long as or longer than width of elytral intervals; color tan to dark brown 8
   Hairs on elytral disc shorter and very inconspicuous, most no longer than the width of elytral intervals; color light tan to tan 7
7. Clypeus deeply emarginate, usually bidentate; labium very small, scarcely elevated above ventral surface of clypeus. South-western Arizona ..... *arizonica* Brown
   Clypeus rounded or truncate; labrum moderately large in size, rather conspicuously raised above ventral surface of clypeus. Vicinity of Tucson, Arizona ..... *mixta* n. sp.
8. Junction of clypeus and frons strongly tumid or frons irregularly, coarsely sculptured or both 9
   Junction of clypeus and frons scarcely tumid; frons finely rugose and granulate, with two vague tubercles in front of the posterior glabrous area; a pronounced ridge present above each eye. Durango, Mexico (*parva* may key out here; see diagnosis of *parva*) ..... *granulifrons* n. sp.
9. Frons deeply, irregularly sculptured or conspicuously tumid near clypeus or both; median transverse band of spines on mesothoracic tibiae usually numbering 9 or less. Not occurring in Baja California 10
   Frons finely, irregularly sculptured, evenly convex to nearly flat; median transverse band of spines on mesothoracic tibia usually numbering 10 or more. Vicinity of Mesquital, Baja California ..... *ochlera* n. sp.
10. Anterior central portion of pronotal disc with one or more long hairs on each side of midline. Chihuahua, Mexico 11
    Anterior central portion of pronotal disc without hairs. Texas, New Mexico, and Arizona 12
11. Size small, 5 mm. or less; color dark brown; from 2 to 8 setae on pronotal disc. Vicinity of Ahumada, Mexico ..... *minuta* Cazier
    Size moderate, over 5 mm.; color reddish-brown; more than 8 setae on pronotal disc. Ojinaga, Mexico ..... *seticollis* n. sp.
12. Clypeus anteriorly distinctly emarginate, bidentate 13
    Clypeus anteriorly scarcely emarginate, rounded 14
13. Moderately slender, brown; male genitalia (Fig. 27) slender, gradually bent downward near tip, proepisternum depressed adjacent to antenna. Vicinity of El Paso, Texas ..... *brunnea* Casey
    Robust, usually dark brown; male genitalia (Fig. 28) bent downward rather abruptly near tip, less slender than in *brunnea;* proepisternum nearly flat adjacent to antenna. Lordsburg, New Mexico; eastern Arizona ..... *knulli* n. sp.
14. Frons deeply reticulate; color brown; size small, ranging between 4.5 and 5.7 mm. Dona Ana County, New Mexico ..... *diminiata* n. sp.
    Frons shallowly reticulate; color tan; size moderate, ranging between 5.8 and 6.6 mm. Casa Grande, Arizona ..... *rufula* n. sp.

Acoma glabrata Cazier

Acoma glabrata Cazier, 1953, pp. 5-6.

Males: Length 5.5 to 8.3 mm.; greatest width 2.7 to 3.9 mm. Color dorsally light reddish-tan with head and pronotum usually darker than elytra. Ventral surfaces, legs, and antennae similar to elytra in color.

Clypeus truncate to shallowly emarginate, sides arcuate. Clypeus abruptly reflexed anteriorly, less so laterally. Clypeal disc flat to barely concave, nearly impunctate to punctate with punctures in latter case separated by a distance of approximately one diameter. Surface between punctures generally smooth and shining. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus tumid. Frons shining with shallow, irregularly confluent, coarse punctures; occasionally granulate and rugosely punctate. Carinate ridge above eye poorly developed. Between anterior edge of ridge and clypeal base is a small, smooth, impressed area. Vertex largely smooth and impunctate.

Pronotum moderately convex, widest medially, with sides sinuate, straight, or moderately arcuate before and behind the median angle. Anterior angles abruptly rounded, obtuse. Pronotal margins complete, well defined but usually lacking the setigerous punctures in the anterior margin evident in most of the species with three-segmented antennal clubs. Pronotum glabrous except along margins; moderately punctate with median line impunctate, vaguely impressed.

Scutellum impunctate, smooth, with midline impressed. Elytral striae shallow, indicated by rows of irregular punctures. Disc of elytra lacking setae, which are present only along margins.

Pygidium setigerously punctate; setae often with minute tubercles at their bases. Punctures separated by a distance equal to two to five diameters; surface between punctures very finely reticulate.

Clypeus ventrally coarsely, setigerously punctate; finely granulate between the punctures. Labrum moderate in size, rounded apically, scarcely elevated above ventral surface of clypeus. Mandible short, setate on outer surface. Mentum mostly obscured by long prosternal setae. Antenna usually 10-segmented, the seventh segment variable in shape, rarely appearing fused with the sixth segment (Specimens from Wellton, Arizona, have nine-segmented antennae with no apparent fusion of segments). Prosternum very narrowly transverse; shallowly depressed in front of each coxa; flat medially (slightly raised in Yuma specimen). Proepisternum variously setigerously punctate, usually impunctate anteriorly; shallowly concave adjacent to antennae. Metasternum centrally sparsely punctate, medially impressed. Fore tibia with impressed line of setigerous punctures throughout its length; above this line, scattered setigerous punctures extend from base to tibial spine. Meso- and metathoracic tibiae each with a median transverse band of eight to ten spines. Outer apical portion of hind tibia punctate. Male genitalia with tip sharply reflexed downward, the lower margin flared outward just before the basal emarginate area.

Female: Unknown.

The above description was based on ten specimens of the type series, ten specimens from the vicinity of Yuma, Arizona, and one from Calexico, California. Most of the type specimens from San Felipe, Baja California, were examined, but are not included in the above description.

Distribution: San Felipe, Baja California (type locality; holotype in AMNH); Yuma, Dome and Wellton, Arizona, and Calexico, California. The California record was not previously given for this species, since the specimen was incorrectly determined as *A. arizonica* and the locality included under that species by Cazier (1953, p. 10).

Variation discussed in Cazier's (1953, p. 6) description is as follows:

> "The series is fairly uniform in color except that a few specimens have the elytra the same reddish brown as the pronotum. They vary in length from 5.0 to 8.5 mm., and in width from 2.3 to 4.1 mm. There is considerable variability in the size and shape of the funicular segments and in

some specimens segments 6 and 7 appear as one elongate segment. The seventh funicular segment may or may not be produced anteriorly, and the length of the projection varies but is always short. In some specimens, the clypeal margins are worn and in others the anterior margin is moderately, deeply, emarginate medially and the lateral angles are therefore prominent. It occurs sympatrically with *stathami* and *nigrita* but can be distinguished from both by its light reddish-brown color."

Acoma glabrata can be distinguished from the other species having the three-segmented antennal club by the light reddish-brown color, lack of setae on the elytral disc, and normally 10-segmented antenna.

Acoma nigrita Cazier

Acoma nigrita Cazier, 1953, p. 6.

Description after Cazier (1953, p. 6).

Male: Similar in every respect to *glabrata* except for its black color, piceous pile and the evident, deeply impressed elytral striae. Length 7.5 mm.; width 3.5 mm.

Female: Unknown.

Distribution: Holotype, male (only specimen known) collected at San Felipe, Baja California, June 15, 1952, by W. J. Gertsch, R. Schrammel, and M. Cazier; in AMNH.

The species, which has ten-segmented antennae, can be distinguished by the characters given above.

Acoma arizonica Brown

Acoma arizonica Brown, 1929, pp. 212-213; Cazier, 1953, p. 10.

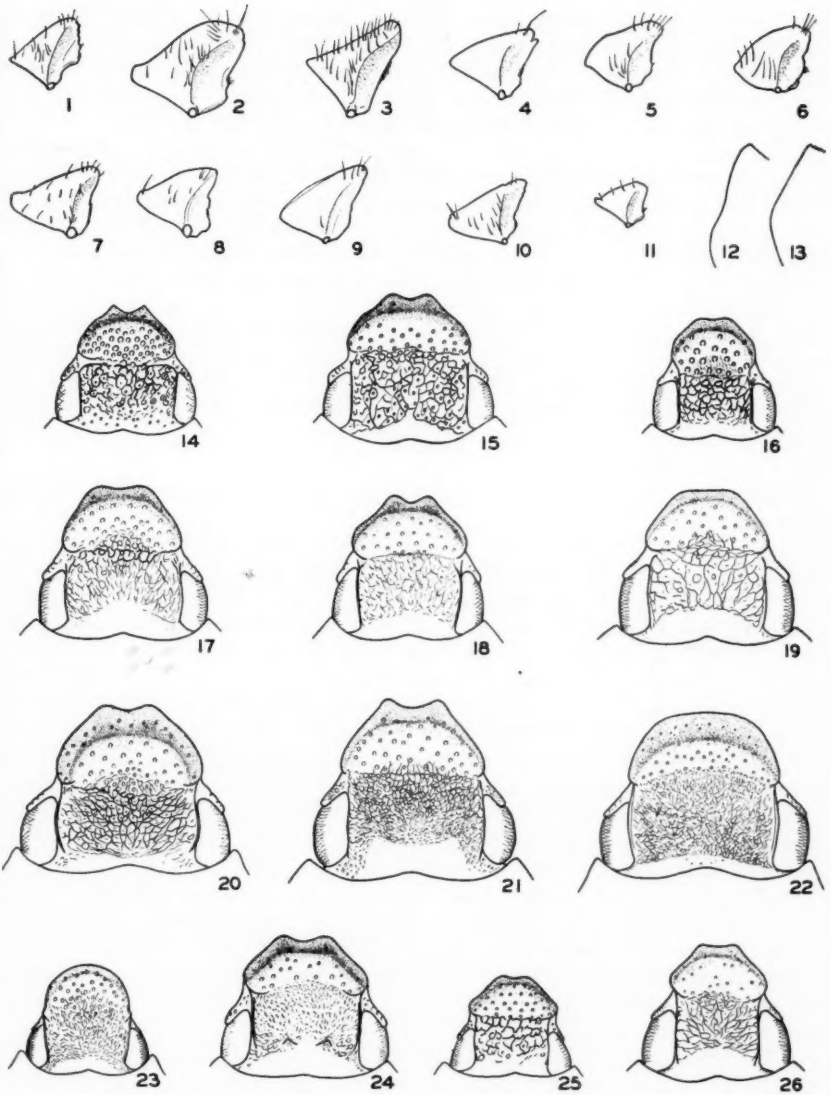
Males: Length 4.7 to 7.6 mm.; greatest width 2.1 to 3.3 mm. Color dorsally reddish-tan to light brown with ventral surfaces, legs, and antennae slightly lighter in color.

Clypeus moderately emarginate, angles of emargination strongly obtuse to bidentate; strongly reflexed anteriorly and laterally; disc concave to flat, coarsely punctate, more so posteriorly, the punctures separated by a distance approximately equal to one diameter. Surface between punctures shining, vaguely alutaceous. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus slightly to moderately tumid. Frons shallowly, rugosely punctate to irregularly, confluently punctate; the smooth surfaces often slightly opaque. Carinate ridge above each eye small, anteriorly bending inward and leaving a small, oblong, smooth area at base of clypeus. Vertex largely smooth and impunctate. Head as in Fig. 18.

Pronotum moderately convex; widest medially with sides arcuate, sometimes nearly straight anteriorly (Fig. 13). Anterior angles sharp, nearly forming right angles. Pronotal margins fine posteriorly and laterally, deep anteriorly with scattered setigerous punctures. Anterior lateral margins often interrupted with setigerous punctures, giving the margins an irregular serrate appearance. Pronotal disc smooth, sparsely punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum finely alutaceous basally; slightly impressed at midline. Elytron with striae often obsolete, indicated by irregular rows of punctures. Intervals irregularly punctate; punctures with short fine setae, usually considerably shorter than width of scutellum, approximately equal in length to width of elytral intervals.

Pygidium finely, setigerously punctate, the punctures separated by a distance of two or three diameters. Surface between punctures very finely, sometimes



Figs. 1-11. Right mandible of *Acoma* spp.: 1, *knulli;* 2, *ochlera;* 3, *incognita;* 4, *arizonica;* 5, *mixta;* 6, *brunnea;* 7, *confusa;* 8, *granulifrons;* 9, *rufula;* 10, *diminiata;* 11, *minuta.*

Figs. 12, 13. Left pronotal margin of *Acoma* spp.: 12, *confusa;* 13, *arizonica.*

Figs. 14-26. Head of *Acoma spp.*: 14, *brunnea;* 15, *knulli;* 16, *diminiata;* 17, *rufula;* 18, *arizonica;* 19, *mixta;* 20, *confusa;* 21, *ochlera;* 22 *incognita;* 23, *parva;* 24, *granulifrons;* 25, *minuta;* 26, *seticollis.*

obsoletely, reticulate. Pygidium, when viewed laterally, convex except near apex, which is slightly flared outward.

Clypeus ventrally setigerously punctate; surface between punctures smooth medially, not noticeably granulate. Labrum small, conical, scarcely elevated above ventral surface of clypeus. Mandible short, with only scattered setae on outer surface; a small tooth usually present in scissorial area; molar area not produced (Fig. 4). Mentum nearly obscured by long prosternal setae. Antenna nine-segmented, the sixth segment barely extended (Fig. 44). Prosternum narrowly transverse, shallowly grooved in front of each coxa, raised medially into a low ridge as high anteriorly as posteriorly. Proepisternum with a few scattered setigerous punctures; slightly concave anteriorly near antenna. Metasternum centrally impunctate or nearly so, midline shallowly depressed posteriorly. Fore tibia with impressed line of setigerous punctures throughout its length. Several to many coarse setigerous punctures are present basally, above the setigerous line. Meso- and metathoracic tibiae each with a median transverse band of six to nine spines. Outer apical portion of hind tibia with scattered coarse punctures, which are occasionally obsolete. Male genitalia (Fig. 31), moderately slender, with a small ventral ridge apical to the basal excavation.

Female: Unknown.

The above description was based on the type, 21 paratypes, and 40 other specimens.

Distribution: Southwestern Arizona: Agua Fria, Aquila, 1 mile N.W. Bouse, Buckeye, Cibola, Ehrenberg, Florence, Gila Bend, Miami, Phoenix, Pima County (type locality; type in CNC), Tempe, Wellton and Yuma County. One specimen was labelled "Texas, Palm Collection", but since *arizonica* has not been collected in eastern Arizona or in New Mexico, I consider the "Texas" record as doubtful. The California record cited by Cazier (1953, p. 10) should be referred to *glabrata*. Collection dates range from May to September, most of the specimens being taken in July and August.

Acoma arizonica may be separated from other species by the following combination of characters: color tan, clypeus distinctly emarginate, labrum small and conical, antenna nine-segmented, sixth segment of antenna disc-shaped, pronotal disc glabrous, elytral setae very short and inconspicuous, and the male genitalia rather abruptly bent downward near the apex.

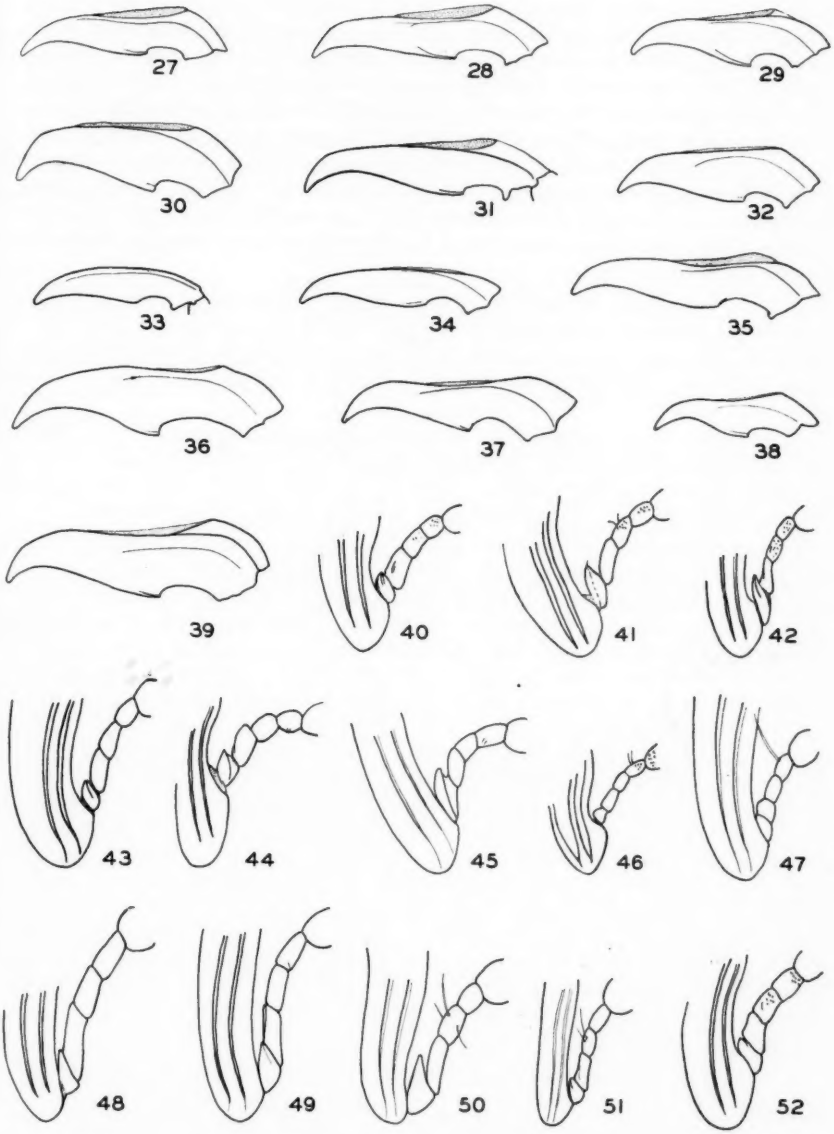
Though easily separated from other species, *arizonica* specimens exhibit so much variation that a complex of species may be indicated. Though most of the variation is mentioned in the description, series from different localities show considerable differences in the shape of the clypeus, depth of punctures on the frons, shape of the mandibles and labrum, and shapes of the pronotum and prosternum.

Specimens taken near the Colorado River are usually larger and more robust than those collected in the vicinity of Phoenix. However, until more is learned of their distribution and habits, it seems best to treat all of the forms as one species.

Acoma mixta new species

Holotype: Male, length 5.4 mm.; greatest width 2.5 mm. Color dorsally reddish-tan to tan with ventral surface, legs, and antennae tan.

Clypeus rounded laterally, truncate anteriorly, moderately reflexed anteriorly, less so laterally; disc shallowly concave, coarsely punctate, with punctures separated by a distance of from one half to one diameter. Discal surfaces



Figs. 27-39. Lateral aspect of ♂ genitalia of *Acoma* spp.: 27, *brunnea;* 28, *knulli;* 29, *diminiata;* 30, *rufula;* 31, *arizonica;* 32, *mixta;* 33, *minuta;* 34, *seticollis;* 35, *granulifrons;* 36, *incognita;* 37, *confusa;* 38, *parva;* 39, *ochlera.*

Figs. 40-52. Left antenna of *Acoma* spp.: 40, *brunnea;* 41, *knulli;* 42, *diminiata;* 43, *rufula;* 44, *arizonica;* 45, *mixta;* 46, *minuta;* 47, *seticollis;* 48, *confusa;* 49, *ochlera;* 50, *incognita;* 51, *parva;* 52, *granulifrons.*

between punctures smooth and shining, becoming dull and roughened posteriorly. Posterior clypeal suture lacking medially. Clypeal-frontal junction moderately tumid. Frons flattened and coarsely, irregularly, confluently punctate and rugose; depressions smooth and shining. Carinate ridge above each eye moderate, anteriorly bending inward before reaching base of clypeus. Vertex posteriorly largely smooth and impunctate. Head as in Fig. 19.

Pronotum moderately convex; widest medially with side arcuate, nearly straight anteriorly. Anterior angles sharply rounded, slightly obtuse. Pronotal margins fine posteriorly and laterally, deep anteriorly with scattered setigerous punctures that occasionally interrupt the anterior lateral margins. Pronotal disc smooth, shallowly punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum finely alutaceous basally, slightly impressed at midline. Elytra with striae obsolete, indicated by irregular rows of punctures. Intervals irregularly punctate; punctures with short fine setae, usually considerably shorter than width of scutellum, approximately equal in length to width of elytral intervals.

Pygidium finely, setigerously punctate; punctures separated by a distance of one to three diameters, becoming more widely spaced medially. Surface between punctures very finely reticulate or alutaceous. Pygidium convex, when viewed laterally, except near apex, which is slightly flared outward.

Clypeus ventrally setigerously punctate; surface between punctures smooth medially, not noticeably granulate. Labrum transverse, nearly truncate at apex; moderate in size, considerably larger than labrum of *arizonica*. Labrum noticeably elevated above ventral surface of clypeus. Mandible short, with scattered setae on outer surface, and with upper margin more rounded than is usual in *arizonica*. Scissorial area lacking a distinct tooth. However, the tooth is sometimes absent in *arizonica* and is therefore not useful for separation of the species. Mandible of *mixta* as in Fig. 5. Mentum nearly obscured by long prosternal setae. Antenna nine-segmented, sixth segment disc-shaped (Fig. 45). Prosternum narrowly transverse; shallowly grooved in front of each coxa; raised medially into a low ridge which is slightly higher posteriorly. Proepisternum nearly impunctate, slightly concave anteriorly near antenna. Metasternum with scattered punctures becoming obsolete medially; midline shallowly depressed posteriorly. Fore tibia with impressed line of setigerous punctures throughout its length. Numerous coarse setigerous punctures extend from base to tibial spine above the setigerous line. Meso- and meta-thoracic tibiae each with a median transverse band of eight or nine spines. Outer apical portion of hind tibia with scattered coarse punctures. Male genitalia (Fig. 32) usually shorter than the genitalia of *arizonica*, but of the same general shape.

Female: Unknown.

Type material: Holotype, ♂, San Xavier near Tucson, Arizona, July 24, 1916 (AMNH). Paratypes: 17 ♂♂, same data as type (AMNH, No. 6595 in CNC, CAS, CU). 1 ♂, Tucson, Arizona, altitude 2400 feet, July 25, 1925, Light, R. B. Streets (CNC). 2 ♂♂, Tucson, Arizona, July 13, 1930, and July 1, 1930, J. S. Yuill, Cartwright collection (USNM).

Other material referred to this species: 1 ♂, Maricopa, Arizona, July 24, 1917, W. D. Pierce collector (USNM).

This species is very closely related to *Acoma arizonica* Brown (the San Xavier specimens being included as paratypes in Brown's description). The tan color and short, inconspicuous elytral setae will separate it from the other

species of *Acoma* and the moderately large labrum and rounded or truncate clypeus will separate it from *arizonica*.

Variation in the type series is evident in the anterior portion of the clypeus, which is evenly arcuate in some, slightly emarginate in others, but more normally is truncate. Color varies from tan to light brown, but never is dark brown as in *confusa* or *knulli*. Size ranges from 4.8 to 7.5 mm. in length and from 2.2 to 3.5 mm. in greatest width. The Tucson specimens are larger than the majority of San Xavier specimens, but otherwise seem similar. The Maricopa specimen, which is not included in the type series, is 8.5 mm. long and differs from the typical *mixta* by having a large conical labrum and almost no setae on the elytra. In other respects, it is essentially similar to *mixta*.

Acoma confusa Van Dyke

Acoma confusa Van Dyke, 1928, pp. 160-161; Saylor, 1948, p. 343; Cazier, 1953, p. 9.

Males: Length 4.7 to 8.4 mm.; greatest width 2 to 3.7 mm. Color dorsally reddish-brown to brown; head and pronotum often slightly darker than elytra. Ventral surfaces, legs, and antennae usually slightly lighter than, sometimes similar to, color of elytra.

Clypeus shallowly emarginate, sometimes bidentate, with sides arcuate; clypeus moderately to strongly reflexed, anteriorly and laterally. Clypeal disc flat to concave, punctate; punctures separated by a distance of one to three diameters. Surface between punctures finely alutaceous. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus slightly convex but not noticeably tumid. Frons shallowly, irregularly, confluently rugose or punctate; the elevated network of ridges with surfaces finely reticulate; secondary punctures not evident. Carinate ridge above each eye moderately to well developed, extending sinuately forward to base of clypeus. Vertex posteriorly largely smooth and impunctate. Head as in Fig. 20.

Pronotum shallowly convex, widest medially, with sides anteriorly slightly sinuate (Fig. 12). Anterior angles acute, appearing extended beside the eyes. Pronotal margins fine posteriorly and laterally, deep anteriorly and setigerously punctate; anterior lateral margins often faintly serrate. Pronotal disc moderately to heavily punctate with very fine secondary punctures between the coarse ones; median line impunctate and slightly impressed. Occasional specimens have two to seven long discal setae on pronotum, half way between midline and median lateral angulation; normally discal setae are absent. Scutellum usually impunctate; shallowly, longitudinally impressed. Each elytron with four or five very irregular, coarsely, punctate striae. Intervals coarsely irregularly punctate; most punctures bearing very long grayish setae, noticeably longer than width of scutellum.

Pygidium coarsely, setigerously punctate; punctures usually close, separated by a distance of less than one diameter; surface between punctures smooth. Pygidium, when viewed laterally, shallowly convex, nearly flat near apex.

Clypeus ventrally setigerously punctate, finely to distinctly granulate between punctures. Labrum moderate in size, triangular, noticeably elevated above ventral surface of clypeus. Mandibles (Fig. 7) large (for species of *Acoma*), not toothed on scissorial or molar surfaces; elongate with tip of mandible usually extending beyond apex of labrum. Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; three-segmented club short, scarcely longer than funicle, a character found only in *confusa* and *incognita*. Sixth segment of antenna elongately triangular (Fig. 48). Prosternum narrowly transverse; distinctly grooved in front of each coxa; elevated medially with top

flattened. Proepisternum setigerously punctate; anteriorly shallowly concave near antenna and densely punctate. Metasternum moderately setigerously punctate, unusually so near anterior portion of midline, midline shallowly depressed posteriorly. Fore tibia with impressed line of setigerous punctures throughout its length; above this line, an irregular line of setigerous punctures extends from tibial base to tibial spine. Meso- and meta-thoracic tibiae each with a median transverse band of from 9 to 12 (typically 11) spines. Outer apical portion of hind tibia with only a few small punctures, occasionally impunctate. Male genitalia (Fig. 37) somewhat variable in curvature, but usually bent downward rather abruptly near apex.

Female: Unknown.

The above description was based on 20 specimens, 17 of them from 15 miles north of San Ignacio, Lower California.

Distribution: Coronados Island (type locality; type in CAS) and Loreto northward to 25 miles south of Santa Rosalia and inland 15 miles north of San Ignacio, all localities in Lower or Baja California. Collection dates range from May 20 (1921) to July 26 (1938).

Specimens of *confusa* may be distinguished by the following combination of characters: emarginate clypeus, finely rugose frons, distinct ridge above eyes, antennal club only slightly longer than funicle, large mandibles, anterior lateral margins of pronotum sinuate and prolonged beside eyes, long elytral setae, and a median transverse band of from 9 to 12 spines on meso- and meta-thoracic tibiae.

I have some doubt that the specimens from San Ignacio are actually conspecific with the Coronados Island (not examined) and Loreto specimens. The Loreto specimen has the thoracic sides noticeably more sinuate and the anterior angles more prolonged than do the San Ignacio specimens. Also the Loreto specimen has the clypeus definitely bidentate, while the San Ignacio specimens have the sides of the emargination rounded. In addition, the thorax is more heavily punctate in the San Ignacio specimens. Though these differences cannot be fully assessed until more material becomes available from the type locality, they appear to be significant.

The variability described for *confusa* by Saylor (1948) and by Cazier (1953), I attribute partly to the fact that they included under the name *confusa* three other species which are subsequently described.

Acoma incognita new species

Holotype: Male, length 8.1 mm.; greatest width 3.4 mm. Color dorsally reddish-brown; frons and vertex piceous. Ventral surfaces, legs and antennae tan to brown.

Clypeus arcuate, only slightly so anteriorly; strongly reflexed anteriorly and laterally; disc shallowly concave and moderately punctate; punctures separated by a distance equal to two or three diameters. Surface between punctures finely alutaceous. Posterior clypeal suture lacking medially. Frontal area evenly rounded, not tumid near clypeus. Frons shallowly, irregularly, confluently rugose or punctate; elevated network of ridges with surfaces finely reticulate; secondary punctures not evident. Carinate ridge above each eye well developed, arcuate, extending forward to base of clypeus. Vertex behind eyes largely smooth and impunctate. Head as in Fig. 22.

Pronotum shallowly convex, widest medially with side anteriorly and posteriorly sinuate. Anterior angles acute, nearly forming right angles; only slightly produced beside eyes. Pronotal margins fine posteriorly and laterally,

deep anteriorly and setigerously punctate; anterior lateral margins finely serrate. Pronotal disc rather heavily punctate, the punctures separated by a distance equal to one or two diameters; extremely small secondary punctures present laterally; median line impunctate, only slightly impressed. A shallow depression, on each side near median angles, bears one or two long setae; otherwise disc lacks setae.

Scutellum with scattered coarse punctures; shallowly longitudinally impressed. Each elytron with five obsolete striae, indicated by irregular rows of coarse punctures. Intervals coarsely, irregularly punctate; most punctures bearing very long, grayish setae, noticeably longer than width of scutellum.

Pygidium coarsely, irregularly, setigerously punctate; punctures close, separated by a distance of one diameter or less. Surface between punctures finely alutaceous basally, smooth apically. Pygidium, when viewed laterally, convex from base to apex.

Clypeus ventrally setigerously punctate, distinctly granulate between punctures. Labrum very small, transverse, scarcely elevated above ventral surface of clypeus. Mandible (Fig. 3) narrow, elongate, not toothed on scissorial or molar surfaces; densely setate on outer surface; tips of mandibles protrude beyond apex of labrum. Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; three-segmented club short, scarcely longer than funicle. Sixth segment of antenna elongately triangular (Fig. 50). Prosternum narrowly transverse; grooved in front of each coxa; slightly elevated medially. Proepisternum setigerously punctate anteriorly and posteriorly, anteriorly shallowly concave near antenna and densely punctate. Metasternum moderately setigerously punctate; depressed portion of posterior midline with numerous setae. Fore tibia with impressed line of setigerous punctures throughout its length. An irregular line of setigerous punctures extends from tibial base to tibial spine above the setigerous line. Meso- and meta-thoracic tibiae each with a median transverse band of 12 or 13 spines. Outer apical portion of hind tibia with three or four coarse punctures. Male genitalia (Fig. 36) very similar to genitalia of *confusa*.

Female: Unknown.

Type material: Holotype, ♂, Venancio, Lower California, July 17, 1938, Michelbacher and Ross Collectors (CAS). Paratypes: 3 ♂ ♂, same data as type (CAS, No. 6596 in CNC).

Other material referred to this species: 2 ♂ ♂, Santiago, Lower California, July 8, 1938, Michelbacher and Ross Collectors (CAS, CNC). 1 ♂, 15 miles W. La Paz, Lower California, July 5, 1938. Michelbacher and Ross Collectors (CAS).

This species, while similar to *confusa* in many respects, can be distinguished from that species by the rounded clypeus, smaller labrum, and distinctive mandibles. The sinuate sides of the pronotum, short antennal club, band of 11 to 13 spines on the mesothoracic legs, densely punctate anterior portion of proepisternum, long eltral setae, and shape of the male genitalia distinguish *incognita* from other *Acoma*.

Variation in the type series is small. Size ranges from 6.8 to 8.5 mm. in length and from 2.8 to 3.6 mm. in greatest width. Color varies from reddish-brown to dark brown. The shape of the clypeus is quite constant, but anteriorly the clypeus may be only moderately reflexed, with the disc nearly flat. Punctures and setae of the pronotum exhibit little variation, but the scutellum is nearly impunctate in one example.

More variation is found in the material not included in the type series. The

specimens from Santiago are smaller, 5.5 to 6.6 mm. in length, light brown to brown in color, have more numerous setae on the pronotum, shorter and fewer setae on the elytra, and have the lateral margins of the pronotum more sinuate. The specimen from 15 miles west of La Paz shows even more striking differences: it is much larger in size, 9.8 mm. in length, is dark reddish-brown dorsally, and has the clypeus evenly arcuate and very strongly reflexed. Another striking difference is present in the labrum, which is moderate in size, truncate and noticeably raised above the ventral surface of the clypeus. The La Paz specimen resembles *Acoma robusta* Van Dyke in many characteristics, except that it has a three-segmented antennal club, instead of the five-segmented club of *robusta*.

***Acoma parva* new species**

Holotype: Male, length 4.7 mm.; greatest width 1.9 mm. Color dorsally reddish-brown to brown with head dark brown. Ventral surfaces, legs and antennae brown to dark brown.

Clypeus evenly arcuate, only slightly reflexed anteriorly and laterally. Clypeal disc flat, coarsely punctate; punctures separated by a distance equal to one or two diameters. Disc centrally, between punctures, with small rugae; a character not noted in the related *incognita*. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus slightly raised; frons shallowly concave near anterior margins of eyes. Frons rugose, not punctate; the rugae scarcely reticulate. Carinate ridge above eye low, extending in an almost straight line to base of clypeus. Vertex posteriorly, behind eyes, faintly reticulate to smooth. Head as in Fig. 23.

Pronotum shallowly convex, widest medially; sides anteriorly and posteriorly slightly sinuate. Anterior angles acute, appearing extended beside eyes. Pronotal margins fine posteriorly and laterally, deep anteriorly and setigerously punctate except near midline; anterior lateral margins faintly serrate. Pronotal disc deeply punctate, with occasional fine secondary punctures; larger punctures separated by a distance of from one half to one diameter. Discal setae lacking; midline impunctate, moderately impressed.

Scutellum with several irregular punctures, not longitudinally impressed. Elytral striae lacking, except for sutural striae, which are faintly indicated. Elytra with confused rows of deep punctures, many bearing setae which are approximately as long as width of scutellum.

Pygidium setigerously punctate; surface between punctures smooth to faintly alutaceous. Pygidium, when viewed laterally, convex from base to apex.

Clypeus ventrally setigerously punctate; distinctly granulate between punctures. Labrum conical, moderate in size, and elevated above ventral surface of clypeus. Mandibles (not dissected) small, not extending beyond apex of labrum; outer surface moderately setate. Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; three-segmented club moderate in length, intermediate between *confusa* and *ochlera*. Sixth segment of antenna triangular (Fig. 51). Prosternum narrowly transverse; vaguely grooved in front of each coxa; slightly elevated medially. Proepisternum setigerously punctate anteriorly and posteriorly; nearly flat anteriorly. Metasternum with scattered coarse punctures; midline with a few setigerous punctures posteriorly and slightly impressed. Fore tibia with impressed line of setigerous punctures extending its length; only occasional scattered setigerous punctures present above this line. Meso- and meta-thoracic tibiae each with a median transverse band of eight or nine spines. Outer apical portion of hind tibia with three to five coarse punctures. Male genitalia (Fig. 38), similar to but smaller than, genitalia of *confusa*.

Female: Unknown

Type material: Holotype, ♂, 10 m. N.W. La Paz, Lower California, October 6, 1941, Ross and Bohart Collectors (CAS), Paratypes: 1 ♂, 15 mi. W. La Paz, Lower California, July 5, 1938, Michelbacher and Ross collectors (CAS). 1 ♂, Arroyo Seco, Lower California, October 6, 1941, Ross and Bohart Collectors (No. 6597 in CNC).

Though closely allied to *incognita* and *confusa*, *Acoma parva* can be separated from them by its smaller size, shallowly reflexed arcuate clypeus with punctate-rugose disc, short mandibles not extending beyond apex or labrum, band of nine or ten spines on meso- and meta-thoracic legs, and moderately long antennal club. The normally sinuate sides of the pronotum, heavily punctate and shallowly convex pronotum, coupled with the other characters will separate *parva* from other *Acoma*.

Variation in the three specimens is slight in the essential characters. Size ranges from 3.6 to 4.7 mm. in length and from 1.5 to 2 mm. in greatest width. Color varies from brown to dark brown. The degree of sinuation of the sides of the pronotum varies from nearly straight to noticeably sinuate; punctures of pronotal disc range from moderate to large in size; in the Arroyo Seco specimen the size of the labrum is considerably reduced. In other respects the specimens are essentially similar.

Acoma ochlera new species

Holotype: Male, length 7.8 mm.; greatest width 3.3 mm. Color dorsally reddish-brown, head brown. Ventral surfaces, legs and antennae tan to reddish-brown.

Clypeus anteriorly moderately emarginate, slightly bidentate, with sides gently arcuate; moderately reflexed anteriorly, considerably less so laterally. Clypeal disc flat, moderately punctate, the punctures separated by a distance equal to two or three diameters; surface between punctures generally smooth and shining. Frontal area adjacent to clypeus faintly tumid; frons nearly flat between eyes; surface very irregularly, coarsely, confluently punctate and rugose; raised ridges not noticeably reticulate; secondary punctures lacking. Carinate ridge above eyes barely indicated and not extending to base of clypeus. Vertex posteriorly largely smooth and shining. Head as in Fig 21.

Pronotum moderately convex, widest medially; sides anteriorly straight or slightly arcuate, not at all sinuate. Anterior angles obtuse, not extended beside eyes. Pronotal margins fine posteriorly and laterally, deep anteriorly and setigerously punctate; anterior lateral margins nearly complete, not noticeably serrate. Pronotal disc moderately punctate with occasional very fine secondary punctures; larger punctures separated by a distance equal to one to two diameters. Discal setae lacking; midline impunctate, not impressed.

Scutellum with a few small basal punctures; vaguely impressed longitudinally. Elytral striae obsolete, indicated by four or five irregular rows of punctures. Elytral intervals with scattered coarse setate punctures, the setae very long, usually longer than width of scutellum.

Pygidium setigerously punctate; punctures separated by a distance equal to one to three diameters; surface between punctures smooth and shining. Pygidium, when viewed laterally, only slightly convex, flat near apex.

Clypeus ventrally setigerously punctate; finely granulate basally between punctures. Labrum conical, moderate in size and elevated above ventral surface of clypeus. Mandible (Fig. 2), large, notched in scissorial and molar areas, moderately setate on outer surface, tips of mandibles usually extending slightly

beyond apex of labrum. Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; the three-segmented club moderate in length, noticeably longer than in *confusa*. Sixth segment of antenna triangular (Fig. 49). Prosternum narrowly transverse; grooved in front of each coxa and flat medially. Proepisternum setigerously punctate, only slightly so medially; shallowly concave anteriorly near antenna. Metasternum rather evenly setigerously punctate; midline impressed and with numerous setae. Fore tibia with impressed line of setigerous punctures extending its length; above this line, numerous setigerous punctures extend from tibial base to tibial spine. Meso- and meta-thoracic tibiae each with a median transverse band of 11 or 12 spines. Outer apical portion of hind tibia with five or more small punctures. Male genitalia (Fig. 39) similar to genitalia of *confusa*.

Female: Unknown.

Type material: Holotype, ♂, Mesquital, Lower California, July 28, 1938, Michelbacher and Ross Collectors (CAS). Paratypes: 6 ♂ ♂, same data as type (CAS, No. 6598 in CNC).

Acoma ochlera has been placed by previous authors under the name *confusa*. It can be separated from that species by the shape of the anterior lateral margins of the pronotum, which are straight or arcuate instead of sinuate. It can be separated from other species by the following combination of characters: emarginate clypeus, slightly swollen frons, obsolete ridge above eye, long elytral setae, moderately large conical labrum with tips of mandibles evident beyond apex, 11 or 12 spines in median band on the middle tibia, the shape of the sixth antennal segment, and by the shape of the male genitalia.

Variation in the type series is moderate. Size ranges from 6.6 to 8.7 mm. in length and from 2.8 to 3.8 mm. in width. Color varies from light to dark brown. The clypeus exhibits variation in the amount of emargination, concavity and density of punctures. The frons may be flat or moderately tumid. The pronotum may occasionally have one or two discal setae. The labrum is often flattened at the apex but is always moderate in size. Some variation is also evident in the curvature of the gentialia. In other respects, the specimens are quite uniform.

Acoma granulifrons new species

Holotype: Male, length 7.0 mm.; greatest width 3.2 mm. Color dorsally dark reddish-brown with head and elytral apices dark brown. Ventral surfaces, legs, and antennae reddish brown.

Clypeus emarginate, vaguely bidentate, with sides nearly straight. Clypeal disc flat, coarsely punctate with punctures separated by a distance equal to one half to one diameter. Surface between punctures nearly smooth, becoming reticulate basally. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus barely tumid. Frons rather opaque, roughened, and irregularly granulate with a few posterior punctures and with two vague tubercles just anterior to the smooth impunctate area of the vertex. Carinate ridge above each eye pronounced and extending forward to the basal edge of clypeus. Head as in Fig. 24.

Pronotum more convex than in *brunnea;* widest medially with sides slightly arcuate. Anterior angles abruptly rounded, acute, but not noticeably extended beside eyes. Pronotal margins fine posteriorly and laterally, deep anteriorly with setigerous punctures. Lateral margins near anterior angles broken by setigerous punctures, having an irregular serrate appearance. Anterior margin medially scarcely produced forward, much less so than in *brunnea*. Pronotal

disc smooth, moderately punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum impunctate; longitudinally impressed near apex. Each elytron with four irregular striae. Striae and intervals coarsely punctate; many punctures bearing a single long fine yellowish seta. Setae approximately as long as the width of the apical portion of scutellum.

Pygidium setigerously punctate; the shallow punctures separated by a distance of one or two diameters. Surface between punctures vaguely reticulate. Pygidium when viewed laterally, convex from base to apex.

Ventrally, clypeus coarsely setigerously punctate; median surface distinctly granulate, being similar in this respect to *minuta*. Labrum small, conical, scarcely elevated above ventral surface of clypeus. Mandible short, with a few short setae on outer surface; vaguely notched in scissorial area; notched and swollen in molar area (Fig. 8). Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; sixth segment not greatly compressed (Fig. 52). Prosternum narrowly transverse, shallowly depressed in front of each coxa, very slightly raised medially, more so anteriorly than posteriorly. Proepisternum shallowly punctate in anterior half; moderately concave in anterior half near antennae, being in this respect similar to *brunnea*. Metasternum centrally with scattered setigerous punctures, medially impressed. Fore tibia with impressed line of setigerous punctures running its length. Basally, above the line, are a few scattered setigerous punctures. Meso- and meta-thoracic tibiae each with a median transverse band of from eight to ten spines. Outer apical portion of hind tibia with a few very large punctures.

Male genitalia (Fig. 35) similar to that of *brunnea*, but larger and lacking the small ventral ridge just apical to the basal excavation.

Female: Unknown.

Type material: Holotype, ♂, Gomez Palacia, Durango, Mexico, May, 1918, A. Busck Collection (USNM). Paratypes: 4 ♂♂, same data as type (USNM, No. 6599 in CNC).

Acoma granulifrons approaches *confusa* in the shape of the pronotal angles, is similar to *knulli* in color and size, and to *minuta* in having the ventral surface of the clypeus granulate. However, the following combination of characters makes the species quite distinct: head dorsally between the eyes opaque, roughened and irregularly granulate with two vague posterior tubercles; carinae above the eyes large, and ventral surface of clypeus distinctly granulate. The male genitalia is also useful in separating this species from other *Acoma*.

Variation in the type series is evident in the shape of the clypeus which in some cases is scarcely emarginate and has arcuate sides. Color shows little variation. The vague tubercles of the frons vary considerably in size and shape but are present in all specimens. Size ranges from 6 to 7.3 mm. in length and from 2.9 to 3.4 mm. in greatest width.

Acoma brunnea Casey

Acoma brunnea Casey, 1889, p. 167; Van Dyke, 1928, p. 159; Cazier, 1953, pp. 11-12.

Males: Length 5.6 to 6 mm.; greatest width 2.4 to 2.6 mm. Color dorsally reddish-brown, with head and pronotum slightly darker than elytra. Ventral surfaces, legs, and antennae similar in color to elytra.

Clypeus rather narrowly and distinctly emarginate, bidentate; sides of clypeus arcuate. Clypeal disc nearly flat, coarsely punctate, the punctures close, rarely separated by a distance equal to one diameter. Surface between punctures shining, smooth to faintly reticulate. Posterior clypeal suture lacking

medially. Frontal area adjacent to clypeus slightly tumid. Frons shallowly to moderately, coarsely, irregularly and confluently punctate; punctures reduced in depth and more irregular posteriorly. Secondary punctures usually lacking in the concavities of the coarse punctures. Carinate ridge above each eye poorly developed, bending inward anteriorly, not extending to clypeus. A small smooth area is present at lateral posterior margins of clypeus. Vertex with scattered fine punctures (in Casey paratype #3) or nearly smooth. Head as in Fig. 14.

Pronotum moderately convex, widest medially; sides slightly arcuate before and behind median angulation. Anterior angles sharp to slightly rounded, forming a right or slightly obtuse angle. Pronotal margins fine posteriorly and laterally, deep anteriorly and punctate. Setae in the punctures are reduced in length or lacking medially. Anterior lateral margins complete, not serrate. Pronotal disc smooth, moderately punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum basally finely alutaceous; slightly impressed along midline, but with impression becoming obsolete near apex. Each elytron with from one to four irregularly impressed striae, which are often obsolete and indicated by irregular rows of punctures. Intervals punctate, with most punctures bearing a single long yellowish seta, usually as long or longer than widest portion of scutellum.

Pygidium setigerously punctate; punctures separated by a distance equal to two or three diameters. Surface between punctures smooth to very finely reticulate. Pygidium convex, when viewed laterally, except near apex which is slightly flared outward.

Clypeus ventrally setigerously punctate; surface between the punctures slightly granulate. Labrum very small, conical, with several setae near apex; scarcely elevated above ventral surface of clypeus. Mandible short, setate on outer surface; vaguely toothed in scissorial area; molar area swollen (Fig. 6). Mentum anteriorly with a roughened setigerous area, partially obscured by long prosternal setae. Antenna nine-segmented; sixth segment slightly compressed laterally (Fig. 40). Prosternum narrowly transverse; faintly grooved in front of each coxa and raised medially, with median ridge ending posteriorly in a small rounded knob. Proepisternum setigerously punctate in outer half; transversely concave anteriorly near antenna. Metasternum centrally setigerously punctate; surface on either side of midline irregular, not evenly convex; midline shallowly depressed. Fore tibia with impressed line of setigerous punctures running its length. Several coarse setigerous punctures are evident basally, above the setigerous line. Meso- and meta-thoracic tibiae each with a median transverse band of seven or eight spines. Outer apical portion of hind tibia with numerous coarse punctures. Male genitalia (Fig. 27) fairly slender with tips curved evenly downward.

Female: Unknown.

The above description is based on four specimens: the type, two paratypes, and one topotype from El Paso, Texas.

Distribution: Vicinity of El Paso, Texas. (Type in USNM).

Acoma brunnea, the first species described in the genus, can be recognized by the following characters: color brown, clypeus distinctly emarginate and bidentate, frons slightly tumid anteriorly and rather deeply, irregularly, coarsely punctate, carina above eyes poorly developed, sixth antennal segment nearly globular, pronotum moderately convex with disc glabrous, and male genitalia slender and gradually curved downward near the apex.

Variation in the few specimens examined is slight and has been included in the description.

***Acoma knulli* new species**

Holotype: Male, length 6.5 mm.; greatest width 3.1 mm. Color dorsally dark reddish-brown with head and elytral apices piceous. Ventral surfaces and legs brown to dark brown, antennal club piceous.

Clypeus emarginate, bidentate; sides arcuate; anteriorly reflexed, less strongly so laterally. Clypeal disc nearly flat, coarsely punctate; punctures separated by a distance equal to one or two diameters. Surface between punctures finely alutaceous. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus moderately swollen.

Frons coarsely, irregularly, confluently punctate; punctures more irregular posteriorly. Smooth surfaces of punctures shining and secondarily punctate. Carinate ridge above each eye extending forward and inward nearly to clypeal suture. Vertex largely smooth and impunctate. Head as in Fig. 15.

Pronotum more convex than in *brunnea*, widest medially, with sides arcuate. Anterior angles sharp, forming right angles. Pronotal margins fine posteriorly and laterally, deep anteriorly with setigerous punctures; anterior lateral margins of pronotum not serrate. Pronotal disc smooth, moderately punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum lacking median longitudinal impression, shallowly punctate basally. Each elytron with five moderately distinct striae. Striae and intervals coarsely punctate; punctures of intervals each bearing a single long fine yellowish seta. Setae approximately as long as the width of the apical portion of scutellum, but generally shorter than the elytral setae of *brunnea*.

Pygidium setigerously punctate, the punctures separated by a distance equal to approximately one diameter; surface between punctures smooth. Pygidium when viewed laterally, convex from base to apex.

Clypeus ventrally coarsely, almost rugosely, setigerously punctate; surface between punctures not noticeably granulate or reticulate. Labrum small, transverse, scarcely elevated above ventral surface of clypeus. Mandibles short; setate on outer surface; vaguely toothed in scissorial and molar areas (Fig. 1). Mentum nearly obscured by long prosternal setae. Antenna nine-segmented; sixth segment disc-shaped (Fig. 41). Prosternum narrowly transverse; shallowly grooved in front of each coxa; depressed medially. Proepisternum setigerously punctate in outer half; slightly concave anteriorly near antenna. Metasternum centrally sparsely punctate, medially impressed. Fore tibia with impressed line of setigerous punctures extending its length. A few scattered setigerous punctures are present basally above the setigerous line. Meso- and meta-thoracic tibiae each with a median transverse band of from eight to ten spines. Outer apical portion of hind tibia coarsely punctate. Male genitalia (Fig. 28) similar to that of *brunnea*, but slightly stouter and more abruptly curved at tip.

Female: Unknown.

Type material: Holotype, ♂, Lordsburg, New Mexico, July 4, 1956, H. and A. Howden at light 10 p.m. (Type No. 6600 in CNC). Paratypes: 3 ♂♂, same data as type (Howden). 1 ♂, Lordsburg, New Mexico, July 19, 1955, D. J. and J. N. Knull Collectors (OSU). 1 ♂, Lordsburg, New Mexico, July 13, 1917, Cornell University Biological Expedition (CU).

Other material referred to this species: 1 ♂, Alamo, Arizona, August 14, 1935, R. H. Beamer (KU). 3 ♂♂, Thatcher, Arizona, June 23, 1950, June 26, 1951, Aug. 2, 1952, E. J. Taylor collection (AMNH). 3 ♂♂, Gila River Valley,

San Carlos, Arizona, August, D. K. Duncan (AMHN, CAS, CU). 1 ♂, Safford Arizona, June 28, 1944, F. H. Parker (AMNH). 1 ♂, Safford, Arizona, June 23, 1954, F. G. Werner, Light trap (UA). 1 ♂, Base of Pinal Mts. Arizona, D. K. Duncan (CAS). 2 ♂♂, Quartzsite, Yuma Country, Arizona, Aug. 20-21, 1927 (CU, CNC).

This species, while closely related to *brunnea*, can usually be distinguished by its more robust appearance, dark reddish-brown color, impunctate vertex, regular elytral striae, shape of the male genitalia and, in the type series, by the prosternum being depressed medially in front of the coxae.

Variation in the type series is evident in the shape of the clypeus, which in one specimen has the sides scarcely arcuate, but more usually has them distinctly rounded; the color is usually dark reddish-brown, but one specimen is brown (perhaps due to fading); irregular punctures of the frons are moderate to heavy, more usually the latter. Size of the type series ranges from 6 to 6.5 mm. in length and from 2.8 to 3.2 mm. in greatest width.

The specimens from the other localities listed show a wider range in size from 4.9 to 6.6 mm. in length and from 2.3 to 3.1 mm. in greatest width. Though most exhibit the dark brown color and robust appearance of the typical *knulli*, the specimens from Alamo and Quartzsite, Arizona, are more slender and much lighter in color, the Alamo specimen being tan. In the Thatcher specimens the median portion of the prosternum is slightly raised and in the San Carlos specimens it is considerably elevated. Since the characters mentioned above appear quite constant in a series of specimens from one locality, the specimens are not included in the type series, and may well represent a complex of closely related species.

This species is named in honor of J. N. Knull, Ohio State University, who collected some of the type material, and who has aided me in many ways.

Acoma diminiata new species

Holotype: Male, length 4.5 mm.; greatest width 2.2 mm. Color dorsally reddish-brown with head slightly darker. Ventral surfaces, legs and antennae slightly lighter in color than elytra.

Clypeus very shallowly emarginate, almost truncate; sides arcuate. Clypeus pronouncedly reflexed anteriorly and laterally. Clypeal disc nearly flat, coarsely punctate; punctures separated by a distance of one to two diameters. Smooth surface between punctures posteriorly finely alutaceous and with scattered minute secondary punctures. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus slightly tumid. Frons deeply, coarsely, irregularly, confluently punctate, punctures becoming shallower and more irregular posteriorly; secondary punctures lacking. Carinate ridge above each eye poorly developed, extending forward to sides of clypeus. Vertex smooth and nearly impunctate. Head as in Fig. 16.

Pronotum moderately convex, similar to that of *brunnea;* widest medially with sides nearly straight before and behind median angulation; anterior angles abruptly rounded, obtuse. Pronotal margins fine posteriorly and laterally, deep anteriorly with setigerous punctures. Anterior lateral margins very slightly serrate. Pronotal disc smooth, moderately punctate; setae lacking except along margin; median line nearly impunctate and vaguely impressed.

Scutellum impunctate; finely alutaceous basally; concave medially (with a seemingly abnormal transverse depression in type). Each elytron with five moderately distinct striae. Striae and intervals coarsely punctate; punctures

of intervals each bearing a very long yellowish seta. Most setae longer than widest portion of scutellum, similar in this respect to *brunnea*.

Pygidium setigerously punctate; punctures separated by a distance approximately equal to one or two diameters. Surface between punctures finely, but distinctly, reticulate. Pygidium when viewed laterally, convex from base to apex.

Clypeus ventrally coarsely, irregularly setigerously punctate; surfaces between punctures not noticeably granulate or reticulate. Labrum very small, rounded; only very slightly elevated above ventral surface of clypeus. Mandibles short, slightly more elongate than mandibles of *brunnea;* setate on outer surface; vaguely toothed in scissorial area and with molar area swollen (Fig. 10). Mentum partially obscured by long prosternal setae, its anterior surface with irregular punctures and finely reticulate. Antenna nine-segmented; sixth segment extended anteriorly (Fig. 42). Prosternum narrowly transverse, faintly grooved in front of each coxa and flat to slightly raised medially. Proepisternum setigerously punctate posteriorly and in outer half; slightly concave near antenna. Metasternum sparsely punctate centrally; medially impressed. Fore tibia with impressed line of setigerous punctures extending its length. Above this line, a few scattered setigerous punctures are present basally. Meso- and meta-thoracic tibiae each with a median transverse band of eight or nine spines. Outer apical portion of hind tibia coarsely punctate. Male genitalia (Fig. 29), very similar to that of *brunnea*.

Female: Unknown.

Type material: Holotype, ♂, Mesquite Station, New Mexico, June 20, 1930, on *L. alyssoides* (USNM). Paratypes: 1 ♂, same locality as type, June 5, 1930 (No. 6601 in CNC). 1 ♂, Dona Ana County, New Mexico, July 1, 1956, J. G. Watts collector (Bottimer collection).

Acoma diminiata can be separated from allied species by its small size, vaguely emarginate clypeus which is distinctly reflexed, irregularly punctate frons, glabrous pronotal disc, and by the shape of the male genitalia.

The greatest variation of the type series is in size which ranges from 4.3 to 5.7 mm. in length and from 2 to 2.5 mm. in greatest width. The clypeus may be truncate or slightly emarginate, the carinae above the eyes are small or obsolete, and the color ranges from reddish-brown to brown.

Acoma rufula new species

Holotype: Male, length 6.4 mm.; greatest width 2.8 mm. Color dorsally light reddish-brown with head and pronotum slightly darker than elytra. Ventral surfaces, legs, and antennae light reddish-brown. Color very similar to that of *arizonica.*

Clypeus feebly emarginate; angles of emargination rounded with sides of clypeus arcuate. Clypeus anteriorly only moderately reflexed, less so laterally; disc concave, coarsely punctate; punctures very close posteriorly, separated by a distance of from one to two diameters anteriorly. Surface between punctures finely alutaceous. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus tumid. Frons flattened, slightly concave behind tumosity; surface roughened with scattered irregular coarse punctures and small ridges; smooth surfaces finely alutaceous. Carinate ridge above each eye poorly developed, becoming obsolete in front of the eyes. Vertex largely smooth and impunctate; anteriorly and laterally finely alutaceous. Head as in Fig. 17.

Pronotum moderately convex; widest medially with sides arcuate. Anterior angles obtuse, sharp, not rounded. Pronotal margins fine posteriorly and

laterally, deep anteriorly and punctate. Anterior marginal punctures lacking setae medially; lateral margins entire, not serrate. Pronotal disc smooth, moderately punctate; setae lacking except along margins; median line nearly impunctate, vaguely impressed.

Scutellum with median longitudinal impression, impunctate. Each elytron with four or five poorly impressed, irregularly punctate striae. Elytral intervals setigerously punctate; setae tan and usually longer than width of apical portion of scutellum.

Pygidium setigerously punctate; punctures separated by a distance equal to approximately one half or one diameter; surface between punctures smooth basally, becoming finely reticulate apically. Pygidium when viewed laterally, convex from base to apex.

Clypeus ventrally coarsely, irregularly setigerously punctate; basal posterior surface finely granulate. Labrum small, connate; slightly elevated above ventral surface of clypeus. Mandibles longer than in *arizonica;* tips scarcely visible; slightly notched in scissorial area (Fig. 9). Mentum nearly obscured by long prosternal setae; coarsely punctate anteriorly, more so than in *brunnea.* Antenna nine-segmented; sixth segment disc-shaped (Fig. 43). Prosternum narrowly transverse, grooved in front and between each coxa and elevated medially, but with the elevated portion centrally depressed (slightly deformed?). Proepisternum setigerously punctate along outer margin; impunctate and slightly concave anteriorly near antenna. Metasternum centrally with scattered setigerous punctures; medially impressed. Fore tibia with impressed line of setigerous punctures extending its length. Above this line, a second row of setigerous punctures extends nearly to tibial spine. Meso- and meta-thoracic tibiae each with a median transverse band of from seven to eight spines. Outer apical portion of hind tibia with numerous coarse punctures. Male genitalia (Fig. 30) rather abruptly bent downward near apex.

Female: Unknown.

Type material: Holotype, ♂, 16 mi. North of Casa Grande, Arizona, June 4, 1940, Elevation 1400 feet, Ingham (AMNH). Paratypes: 6 ♂ ♂, same data as type (AMNH, No. 6602 in CNC, Parker collection).

This species has been confused with *arizonica.* However, the presence of long elytral setae will readily separate it from that species. The characters distinguishing *rufula* from other *Acoma* are: light reddish-brown color, clypeus shallowly emarginate, frons flat and concave behind anterior tumosity and shallowly punctate or rugose, carinae above eyes obsolete, pronotal disc glabrous, labrum small and connate, and male genitalia stout and abruptly bent downward near apex.

Variation in the seven specimens seen is most noticeable in the shape of the clypeus, which has the sides broadly arcuate in the type and only moderately arcuate in the paratypes. The length of the elytral setae varies, but they are always conspicuous and are at least as long as the width of two elytral intervals. Variation in size is slight, the specimens ranging from 5.6 to 6.4 mm. in length and from 2.5 to 2.8 mm. in greatest width.

Acoma minuta Cazier

Acoma minuta Cazier, 1953, pp. 10-11.

Males: Length 4.2 to 5 mm.; greatest width 1.9 to 2.3 mm. Color dorsally yellowish-brown to dark reddish-brown, with pronotum usually darker than elytra and head often piceous. Ventral surfaces, legs, and antennae only slightly lighter in color than elytra.

Clypeus varying from shallowly emarginate to truncate, with sides slightly arcuate; sharply reflexed anteriorly. Disc of clypeus flat to slightly concave, with even, coarse punctures separated by a distance equal to one to three diameters. Surface between punctures smooth and shining. Posterior clypeal suture lacking medially. Frontal area adjacent to clypeus tumid. Frons very deeply and coarsely, irregularly punctate, more so anteriorly than posteriorly; fine secondary punctures are occasionally present in the depressions. Small carinate ridge above each eye extending forward, in most cases, to base of clypeus. Vertex largely smooth and impunctate. Head as in Fig. 25.

Pronotum shallowly convex, widest medially; sides scarcely to moderately arcuate anteriorly. Anterior angles sharply, obtusely rounded. Pronotal margins fine posteriorly and laterally, moderately impressed anteriorly and with setigerous punctures. Lateral margins near anterior angles broken by a few setigerous punctures, having an irregular serrate appearance. Pronotal disc smooth between numerous coarse punctures; vaguely impressed anteriorly on either side of median line, with from one to four setae in each depression. Several specimens lack the vague depressions, but the setae are present in all specimens examined.

Scutellum occasionally with one or two coarse punctures; apically minutely punctate. Each elytron has four or five very irregular, shallow striae. Striae and intervals coarsely punctate; most punctures bearing a single long, fine, tan seta which is approximately as long as the width of the apical portion of scutellum.

Pygidium finely to moderately setigerously punctate; punctures separated by a distance equal to three to five diameters; surface between punctures smooth or nearly so. Pygidium, when viewed laterally, convex from base to apex.

Clypeus ventrally coarsely, setigerously punctate; surface medially, between punctures, finely granulate. Labrum minute, often scarcely visible; scarcely elevated above ventral surface of clypeus. Mandibles very small and short, setate along anterior margin of outer surface; lacking teeth in scissorial and molar areas (Fig. 11). Mentum largely obscured by long prosternal setae. Antenna nine-segmented; sixth antennal segment slightly compressed to globular (Fig. 46). Prosternum narrowly transverse; grooved by each coxa and moderately elevated medially, but not to the extent found in *brunnea*. Proepisternum with scattered setigerous punctures, more numerous posteriorly than anteriorly; proepisternum anteriorly shallowly concave near antennae. Mesosternum centrally with scattered coarse punctures and with large irregular indentations on either side of the impressed midline (possibly due to drying from alcohol, but present in all specimens seen). Fore tibia with impressed line of setigerous punctures extending its length. A partial row of setigerous punctures is evident basally, above the setigerous line. Meso- and meta-thoracic tibiae each with a median transverse band of from seven to eight spines. Outer apical portion of hind tibia usually coarsely punctate. Male genitalia (Fig. 33) smaller than related species, usually curved dorsally from base to apex.

Female: Unknown.

Material examined: 40 specimens of type series, all from Ahumada, Chihuahua, Mexico, July 22, 1952, at light, R. B. and J. M. Selander (Type in AMNH).

Acoma minuta can be distinguished from all other known species except *seticollis* and the species in the *confusa* group by the presence of the few long setae on the elytral disc. It can be separated from these species by the follow-

ing characters: color brown to dark brown, size small, clypeus distinctly reflexed and shallowly emarginate, frons deeply and irregularly punctate, and sixth antennal segment globular. The male genitalia is also distinctive.

Variation in the series examined is small and has been included in the description.

***Acoma seticollis* new species**

Holotype: Male, length 5.6 mm.; greatest width 2.5 mm. Color dorsally yellowish-brown with pronotum slightly lighter in color. Ventral surfaces, legs, and antennae similar in color to pronotum.

Clypeus very shallowly emarginate, not bidentate; sides nearly straight, becoming abruptly rounded posteriorly. Clypeus moderately reflexed anteriorly, less so laterally; disc nearly flat with coarse punctures scattered irregularly over surface, becoming more numerous posteriorly. Surface between punctures smooth and shining. Posterior clypeal carina lacking medially; junction between clypeus and frons slightly tumid. Frons moderately, coarsely, irregularly, confluently punctate and rugose. Depressions smooth, with occasional shallow secondary punctures. Indistinct ridge above each eye extending forward to base of clypeus. Vertex largely smooth and impunctate. Head as in Fig. 26.

Pronotum moderately convex; widest medially with sides nearly straight before and behind median angulation. Anterior angles rounded, obtuse. Pronotal margins fine posteriorly and laterally, moderately impressed anteriorly and setigerously punctate. Lateral margins near anterior angles broken by a few setigerous punctures, having an irregular serrate appearance. Pronotal disc smooth between numerous large and moderately sized punctures; many of the larger discal punctures bear long conspicuous setae, which are most numerous in a transverse median band across pronotum.

Scutellum impunctate; lacking any median longitudinal impression. Elytral striae obsolete, indicated by five irregular rows of punctures. Elytral intervals irregularly punctate, most punctures bearing a single long, fine, tan seta which is approximately as long as the width of the apical portion of scutellum.

Pygidium moderately, setigerously punctate; punctures separated by a distance of two or three diameters; surface between punctures smooth or nearly so. Pygidium, when viewed laterally, shallowly convex from base to apex.

Clypeus ventrally coarsely, setigerously punctate; surface medially between punctures finely granulate. Labrum very small and conical; scarcely elevated above ventral surface of clypeus. Mandibles (not dissected) very small and short; no setae evident on outer surface. Mentum largely obscured by long prosternal setae. Antenna nine-segmented; sixth antennal segment globular (Fig. 47). Prosternum narrowly transverse, shallowly grooved by each coxa and evenly rounded between. Proepisternum setigerously punctate posteriorly and along outer margin; proepisternum anteriorly flat near antenna not at all concave. Mesosternum centrally with only a few scattered punctures; not unevenly indented as in *minuta;* midline slightly depressed posteriorly. Fore tibia with impressed line of setigerous punctures extending its length. Above this line, a partial row of setigerous punctures extends from base nearly to tibial spine. Meso- and meta-thoracic tibiae each with a median transverse band of seven or eight spines. Outer apical portion of hind tibia coarsely punctate. Male genitalia (Fig. 34) similar to genitalia of *minuta* but larger.

Female: Unknown.

Type material: Holotype, ♂, Ojinaga, Chihuahua, Mexico, June 13, 1948, H. S. Barber (in Bottimer collection).

Though only the holotype has been seen, the species is so distinctive that it seemed desirable to include its description here. It may be readily separated from other *Acoma* by the following combination of characters: light tan color, shallowly emarginate clypeus, long elytral setae, shape of the male genitalia, and by the numerous long setae of the pronotal disc. It is most closely related to *minuta.* but differs in color, size and the more numerous pronotal setae.

I would like to express my thanks to Mr. L. J. Bottimer, of Kerrville, Texas, for making this striking species available for study.

Summary

Only the species of *Acoma* having a three-segmented antennal club are considered. *Acoma nigrita* Cazier, *glabrata* Cazier, *confusa* Van Dyke, *arizonica* Brown, *minuta* Cazier and *brunnea* Casey are redescribed and the new species *incognita, parva mixta, granulifrons, ochlera, seticollis, knulli, diminiata* and *rufula* are described. A key to the species, figures of important morphological characters and a distributional map are also included.

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Identities of Lonchaeid Flies Described by Zetterstedt, with Notes on Related Species (Diptera)[1]

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Zetterstedt (1838-1855) described 11 species of Lonchaeidae from the Palaearctic region: *Lonchaea albitarsis*, *L. crassinervis*, *L. deutschi*, *L. flavidipennis*, *L. birticeps*, *L. hyalipennis*, *Earomyia lonchaeoides*, *L. metallica*, *L. pallipennis*, *L. palposa*, and *L. parvula*. He erected the genus *Earomyia* for *lonchaeoides* when he described that species but assigned all of the other species he dealt with to the genus *Lonchaea* Fall.

Although some of these species have been recognized, others have been regularly misinterpreted ever since Zetterstedt described them more than a century ago. Different authors have applied most of the names differently and, with the progressive refinement of species concepts in the family, it has become imperative to restudy the available type material of all the species in order to establish their identities.

Collin discovered the holotype of *L. hyalipennis* in the Copenhagen Museum and has recently (Collin, 1953a) presented an excellent diagnosis of that species. Mr. Günter Morge, Humbolt-Universität zu Berlin, is studying the type of *L. flavidipennis;* the type of *L. metallica* has not been found and the species remains unrecognizable.

This paper clarifies the identities of the eight remaining species. The types, in the Zetterstedt Collection, Zoological Institute, Lund, Sweden, are redescribed below; comparisons are drawn between these and closely related species and some of the synonymies are indicated. Where necessary, lectotypes are designated.

Measurements provided in the descriptions were made by means of a Bausch and Lomb dissecting microscope with a squared grid in a 15X ocular lens in combination with a 7.5X objective lens. The factor to convert the figures in parentheses to millimeters is .13. The length of the frons was taken as the distance between the dorsal margin of the lunule and the anterior ocellus; the width of the frons, unless otherwise specified, was taken as the minimum width. Measurements of the third antennal segment were made on the inner face and are maximum lengths and widths. For the location of various hairs and setae see McAlpine (1956b, p. 523, Figs. 1-3).

Lonchaea albitarsis Zetterstedt

Figs. 1, 14-16, 31, 32

Lonchaea albitarsis Zetterstedt, 1838, Ins. Lapp. 1: 754 (in part); 1847, Dipt. Scand. 6: 2351, var. "a" (at least in part); 1855, Dipt. Scand. 12: 4786 (in part); Hackman, 1956, Notul. ent. 36: 93, 108, 109-110, Figs. 77, 82, 86, 92, 97.

?*Lonchaea hyalipennis*, Hennig, 1948, Acta zool. Lilloana 6: 370-374, 392, 396-400.

Specimens nos. 384 to 387 in Insecta Lapponica section of the Zetterstedt collection are syntypes of *L. albitarsis*. Their labels bear the following data: No. 385, "*L. albitarsis* ♂ Turtola, Lapp. Torn."; nos. 384, 387: "Turtola, Lapp."; no. 386, "*L. albitarsis* ♂ Lycksele". Nos. 384 (♀), 385 (♂), and 387 (♀) each have associated with them the remains of a puparium. Unquestionably these are the specimens referred to in the original description (Zetterstedt, 1838) as follows: "*Pupae plures cylindricae nudae* 8 *annulatae brunnae sub cortice Pini*

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ad pagum Turtolam Lapponiae Tornensis d 4. *Jun. captae; ex his imagines utriusque sexus egressae d.* 22-25 *ejusdem mensis, et aliae d. sequentis* 3. *Julii.*" No. 386 (♂) is the specimen upon which Zetterstedt based the statement "*Hab. in Lycksele rar.*"

These four specimens represent at least two species. No. 386 is of *Lonchaea affinis* Malloch (Figs. 12, 13), an apparently Holarctic species described (Malloch, 1920) from New Hampshire, U.S.A. I have seen other specimens of both sexes of this species from Abisko, Sweden, and I consider that it is either identical with or very closely related to *L. laxa* Collin (1953b). No. 387 appears to be a female of *L. affinis* but is somewhat damaged and greased and I cannot be certain. Nos. 384 (♀) and 385 (♂) are clearly conspecific and I hereby designate specimen no. 385 as lectotype of *L. albitarsis* Zetterstedt.

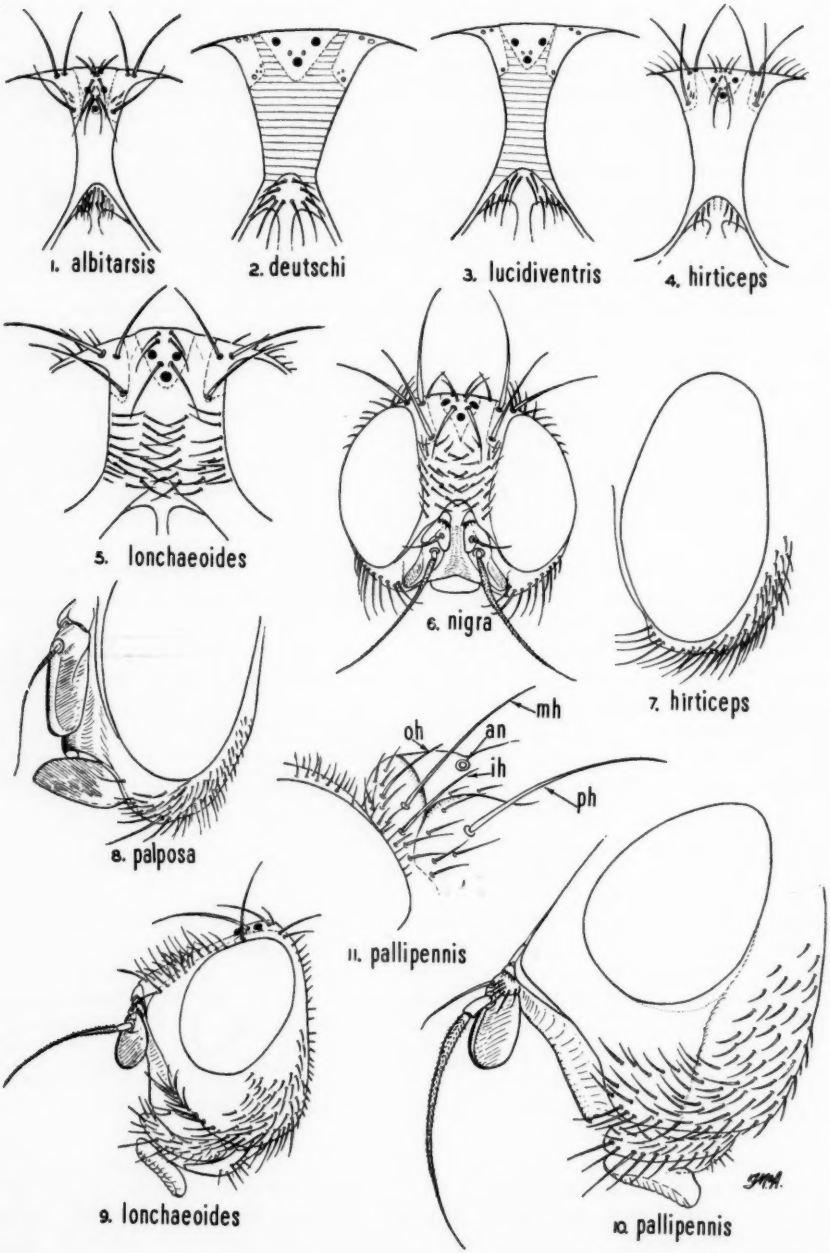
Because the series from which Zetterstedt described *L. albitarsis* was mixed, his description is ambiguous and it is impossible to provide all of the synonymy for the species. The figures and descriptions provided by Hennig (1948) strongly indicate however, that *L. hyalipennis*, Hennig (not Zetterstedt, 1847), is *L. albitarsis* Zett. and not *L. obscuritarsis* Collin as suggested by Collin (1953b).

L. albitarsis is a rather large, black, hairy species similar in many respects to *L. affinis* but with whitish wings. The calyptrae and their fringes are dark brown. All the tarsi are entirely brownish with paler obscurely yellowish metatarsi. The orbital plate is hairy above the orbital bristle; the eye is bare; there are several stigmatal hairs on the epimeron, and the notopleuron has a few weak hairs in addition to the two notopleural bristles; the disc of the scutellum is covered with numerous, erect, fine hairs.

L. albitarsis and *L. obscuritarsis* are very closely related species but *L. albitarsis* differs in having several stigmatal hairs (usually one in *L. obscuritarsis*) and several hairs behind the sternopleural bristle (bare in *L. obscuritarsis*). In addition, the shapes of the epandrium, of the surstylus (=inner lamellate process of Collin) and of the base of the aedeagus differ from those of *L. obscuritarsis* [compare Figs. 14-16 with Fig. 23 of Collin (1953b)].

Lectotype, ♂, Redescribed.—Frons (Fig. 1) dull black; rather narrow; twice as long as wide (4.3:2.1); narrowing sharply to the middle, the lateral margins strongly concave; narrowest about midway between the anterior ocellus and the lunule; densely long-haired. Orbital plate bluish-black, with three setaceous hairs arising above the orbital bristle. Lunule black, with approximately 20 setaceous hairs. Parafacial narrow, about as wide as the width of two rows of the larger ommatidia. Gena (cheek or jowl) densely bristly-hairy, the hairs strongest where the genal hairs merge with the oral setulae. Oral setulae, 6-8, in a single irregular row; without an outstanding vibrissa-like bristle. Antenna brownish-black; third segment almost twice as long as wide (3.2:1.7). Palpus strongly bristled on the lateral and apical margins. Third antennal segment uniformly brown; slightly more than twice as long as wide (3.3:1.5). Compound eye bare.

Mesonotum densely long-haired; many hairs in the prescutellar area caudad of the transverse row of strong bristles. Notopleuron with four to six fine setulae on the discal area above the two bristles. Mesopleuron with seven bristles in the posterior row; with two rather strong, anteriorly directed hairs on the anterodorsal declivities. Epimeron with three stigmatal hairs (including stigmatal bristle). Sternopleuron strongly hairy above, the hairs becoming


1. albitarsis
2. deutschi
3. lucidiventris
4. hirticeps
5. lonchaeoides
6. nigra
7. hirticeps
8. palposa
mh
oh
an
ih
ph
11. pallipennis
9. lonchaeoides
10. pallipennis

progressively weaker below; three or four hairs above the sternopleural bristle, one or two caudad of it. Scutellum with numerous hairs on the disc, margins, and apex, these hairs extending far cephalad of the lateral scutellar bristles both at the margins and on the disc. Lateral scutellar bristles about midway between the apical scutellars and the base of the scutellum.

Front and mid femora bristly-hairy posteriorly; hind femur almost bare behind, little broader than hind tibia. Hind tibia strongly arched. Tarsi brownish with obscurely yellowish metatarsi. Calyptrae dusky-brown, their borders and fringes dark brown. Wings milky white with very pale yellow veins; microtrichiae white; distance between apices of *Sc* and R_1 much greater than the maximum width of the costal cell (4.0:2.66); costal setulae becoming peglike slightly beyond middle of costal cell and ceasing slightly before reaching midway between apices of R_{2+3} and R_{4+5}.

Abdomen shining black dorsally; without apparent dusting.

Genitalia as shown in Figs. 14-16.

Female (described from specimen no. 384).—Differing from male as follows: In general much shorter haired and somewhat more shining.

Frons about as long as wide (3.0:3.0); distinctly narrowed anteriorly; narrowest at lunule, about three-fourths as wide here as at the anterior ocellus (3.0:4.0). Orbital plate with four or five setulae dorsad of orbital bristle. First and second antennal segments and inner base of the third reddish-brown. Third antennal segment about two-thirds as wide as long (2.0:3.1).

Hairs of the mesonotum much shorter and more strongly appressed than in the male. Notopleuron with two or three hairs confined to the mid-dorsal area. Epimeron with two stigmatal hairs on one side and three on the other.

Apical portion of ovipositor as shown in Figs. 31, 32.

Lonchaea deutschi Zetterstedt

Figs. 2, 17, 18, 33

Lonchaea deutschi Zetterstedt, 1838, Ins. Lapp. 1:754.
?*Lonchaea sarekensis*, Hackman, 1956, Notul. ent. 36:101-2, Figs. 46, 51, 56.

There are eight specimens standing under the name *Lonchaea deutschi* Zetterstedt in the Zetterstedt collection at Lund; probably all of them are syntypes. Three males and two females are labelled "*L. Deutschi.* Juckasj." ("Juckasjervi" for no. 383); one male is labelled "*L. Deutschi*, ♂, Haparanda" and two females are unlabelled. There can be little doubt that these are the specimens that Zetterstedt (1838) referred to in the original description as follows: "*scilicet ad Juckasjervi Lapponiae Tornensis frequenter*, 21-29. *Jun., et ad Bjourkvik et Giebostad Nordlandiae*, 17-22. *Jul. a me inventa* (*Lapponia; Botnia borealis, ex. gr. ad Pello* 4. *Jun. et ad Haparanda* 20. *Maj.*)". The following discussion is based on specimens no. 382, a male labelled "*L. Deutschi*, ♂, Juckasj", and no. 383, a female labelled "*L. Deutschi*, ♀, Juckasjervi." I hereby designate specimen no. 382 as the lectotype.

Figs. 1-4, 7-8, *Lonchaea* spp., Fig. 6, "*Lonchaea*„ *parvula* Zett (=*nigra* Mg.). Figs. 5 and 9, *Earomyia lonchaeoides* Zett. Figs. 10-11, *Dasyops pallipennis* (Zett.).

1-6. Anterior views of frons and adjoining areas: 1-2, ♂, lectotype; 3, ♂, Leipzig; 4, ♂, holotype; 5, ♀, lectotype; 6, ♀, holotype. 7. Lateral aspect of left cheek and compound eye, ♂, holotype. 8. Left anterolateral aspect of lower portion of head, ♂, holotype. 9. Left lateral aspect of head, ♀, lectotype. 10. Left lateral aspect of lower portion of head, ♀, holotype. 11. Dorsolateral aspect of right humerus and adjoining areas of mesonotum, ♀, holotype; bristles designated: ih, inner humeral, mh, median humeral, oh, outer humeral, ph, post humeral, an, position of anterior notopleural.

L. deutschi Zetterstedt belongs in a group of rather small (somewhat smaller than *chorea* Fab.), dullish, dark brown to black species with the following characters in common: tarsi entirely dark; calyptrae dusky with dark brown margins and fringes; oral setulae in a single row.

The following key summarizes the most obvious differences between the described species known to me that fall within the above diagnosis:—

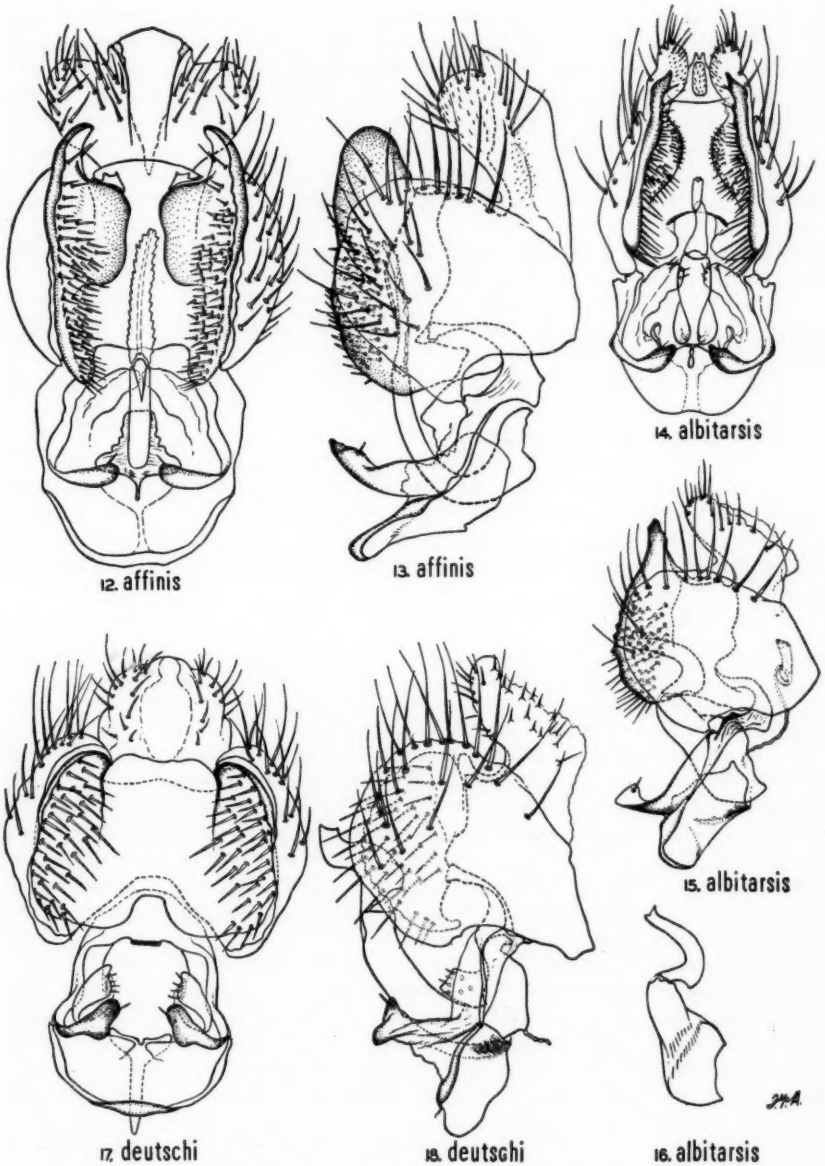
1. Eyes distinctly hairy; with several stigmatal hairs 2
   Eyes ostensibly bare; with a single stigmatal hair 3
2. Distance between *Sc* and R_1 greatly exceeding the maximum width of the costal cell ..... *birticeps* Zett.
   Distance between *Sc* and R_1 about half as great as width of costal cell ..... *alni* Ringdahl
3. Orbital plate bare above orbital bristle in both sexes; frons hour-glass-shaped in male (Fig. 3); sides almost parallel in female; distance between apices of *Sc* and R_1 less than length of humeral crossvein ..... *lucidiventris* Becker
   Orbital plate with several setulae arising dorsad of orbital bristle in both sexes; frons wedge-shaped anteriorly in male (Fig. 2), less distinctly narrowed in female; distance between apices of *Sc* and R_1 at least as long as the humeral crossvein 4
4. Third antennal segment less than twice as long as wide; distance between apices of *Sc* and R_1 greater than maximum width of costal cell ..... *deutschi* Zett.
   Third antennal segment more than twice as long as wide; distance between apices of *Sc* and R_1 less than the maximum width of costal cell ..... *angustitarsis* Malloch

L. lucidiventris and *L. angustitarsis* are closely related to *L. deutschi.* I discuss the former species below and mention it here only because it may have been confused with *L. deutschi* by some European authors. The description and figure provided by Collin (1953b) strongly indicate that the British species he referred to as *L. deutschi* Zetterstedt is *L. lucidiventris* Becker (see Hackman, 1956, p. 153, and remarks under *L. lucidiventris* below). *L. angustitarsis* appears to be restricted to the Nearctic region and, consequently, has not been treated by European workers. *L. deutschi* of Coquillet (1900, p. 459) from Alaska, is not referable to *Lonchaea sens. str.*

Lectotype, ♂, Redescribed.—Frons (Fig. 2) strongly narrowed from vertex to lunule, the sides almost straight; uniformly dulled with greyish-brown pollen; strongly haired, the hairs about two-thirds as long as the orbital and anterior ocellar bristles. Orbital plate with at least three hairs dorsad of the orbital bristle. Lunule (Fig. 2) uniformly pollinose; with 10 setulae, the anterior (ventral) ones strongest, i.e., about as long as the lunule is wide and decidedly longer and stronger than the marginal hairs on the first and second antennal segments. Parafacial almost linear in the middle, but wider opposite base of antenna and at junction of parafacial and gena. Cheek (jowl) very narrow, little more than half as wide as width of third antennal segment. Oral setulae uniserial; 12 or 13 in number, beginning directly below the lowermost part of the compound eye and continuing forward to the vibrissal angle; nearly uniform in size, about as long as the hairs on the frons. Compound eye bare, about 1.0 mm. high, and 0.5 mm. wide. Third antennal segment entirely brownish-black; distinctly less than twice as long as wide (2.25:1.5).

Mesonotum uniformly brownish pollinose; thickly and strongly haired, the hairs on the dorsum, in profile, almost as long and strong as the posterior mesopleural bristles. Principal mesonotal bristles difficult to distinguish among the hairs. Scutellum thinly brownish dusted; with three lateral and four apical setulae in addition to the usual scutellar bristles. Epimeron with one stigmatal hair. Mesopleuron with six hair-like posterior mesopleural bristles, the second, third, and fourth the strongest; without outstanding anterodorsal meospleural hairs or bristles.

Front and mid femora thickly long-haired posteriorly, the longest hairs



Figs 12-18. Ventral and right lateral aspects of male genitalia of *Lonchaea spp*: 12 and 13, syntype of *L. albitarsis* Zett. from Lycksele — no. 386; 14, 15, and 16 lectotype; 16, right lateral aspect of aedeagus; 17 and 18, lectotype.

distinctly longer than the greatest width of the femur. Tarsi entirely dark brown. Wings with a distinctly brownish cast – the wing membrane being covered with very numerous, rather large, brownish microtrichia. Distance between apices of *Sc* and R_1 much greater than greatest width of costal cell (1.33:0.8). Calyptrae light brownish with dark-brown borders and fringes.

Abdomen distinctly dulled dorsally and ventrally by a very evident coating of greyish-brown pollen.

Genitalia as shown in Figs. 17, 18.

Female (described from specimen no. 383).–Differing from the male as follows: In general much more shining and shorter haired. Frons wider, not nearly so much narrowed anteriorly, the sides sub-parallel; almost as long as wide (3.0:2.6); hairs shorter, three arising dorsad of orbital bristle. Third antennal segment about 1¼ times as long as wide (2.0:1.6).

Hairs of mesonotum much shorter than the posterior mesopleural bristles; principal mesonotal bristles easily distinguished. Scutellum with two apical setulae.

Front and mid femora not so long-haired, and wings lighter in colour than in the male.

Apical segment of ovipositor (Fig. 33) with two long, gently curved, brown hairs near the base, and another long, straight, subapical pair; both pairs arising on dorsal aspect; basal pair considerably longer than length of apical segment of ovipositor, the subapical pair somewhat shorter. (Note: Some of the hairs of the apical segment, particularly on the ventral surface, have apparently been rubbed off. Compare Fig. 33 with Fig. 56, Hackman, 1956.)

***Lonchaea lucidiventris* Becker**

Figs. 3, 34

Lonchaea lucidiventris Becker, 1895, Berlin Ent. Zeit. 40: 334; Hennig, 1948, Acta zool. Lilloana 6:368, 392, Fig. 36; Hackman, 1956, Notul. ent. 36:103, Figs. 45, 50, 55, 58.

Lonchaea deutschi, Schiner, 1864, Fauna Austr. 2:90 (synonymy by Becker, 1895); Collin, 1953, Trans. Soc. British Ent. 11:200, Fig. 17.

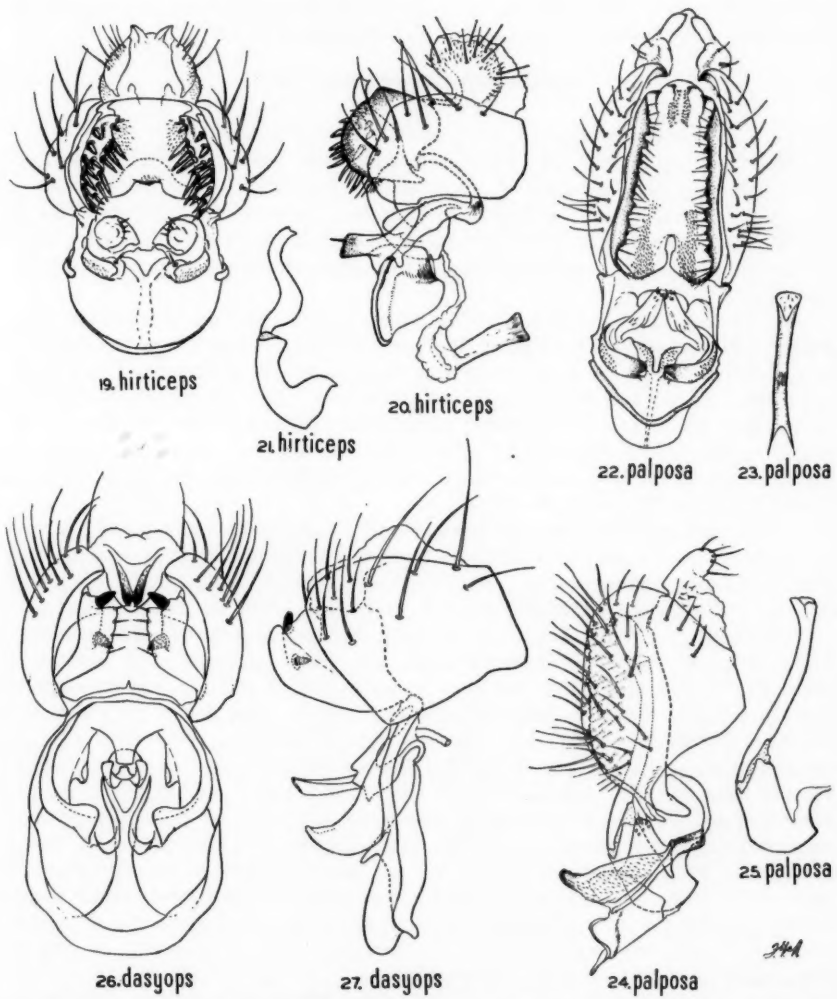
The above synonymy is very probably incomplete; it is restricted to those citations that I consider certainly apply to *L. lucidiventris* Becker. *L. lucidiventris* seems to be more common in collections than is *L. deutschi*. Among the specimens before me is a male from a series that Dr. W. Hennig reared from larvae and pupae found "hinter Laubbaüme (Eichen?) Rinde" in Leipzig on June 22, 1946. Hennig (1948) identified this series as of *L. lucidiventris* by comparing it with the type of that species in the Zoologischen Museum, Berlin, and I have accepted his identification.

L. lucidiventris differs from *L. deutschi* as follows: In general it is a shinier species with shorter, finer, sparser, and more closely appressed hairs throughout. In the male, the frons (Fig. 3) is distinctly hour-glass-shaped rather than wedge-shaped, with the narrowest point about midway between the anterior ocellus and the lunule; at this point it is about three-fifths as wide as at the anterior ocellus (1.5:2.5); length: width ratio, about 2.5 (3.6:1.5). The hairs on the frons are distinctly shorter, and none arises dorsad of the orbital bristle. The row of oral setulae (uniserial) is less uniform consisting of five or six relatively strong, setaceous hairs, which gradually diminish in size caudad, with several weaker ones in front (dorsad) of them. The lunule (Fig. 3) has 14 setulae instead of 10, and all are shorter than the width of the lunule. The third antennal segment is longer, i.e. twice as long as wide (2.33:1.16).

The mesonotum is black and distinctly more shining; the bristles are more easily distinguished from the hairs. There is little difference between the

mesopleura, sternopleura, and epimera of the two species, but because the hairs are sparser and weaker in *L. lucidiventris*, the bristles appear stronger. The scutellum has six or seven lateral scutellar setulae and four or five apical scutellar setulae in addition to the four strong bristles. The wing is clearer with lighter-brownish veins, and less dense, less appressed and distinctly shorter microtrichia. The distance between the apices of *Sc* and R_1 shorter, but little more than half the maximum width of the costal cell.

Abdomen less dull, the pollen thinner.



Figs. 19-25. Ventral and right lateral aspects of male genitalia of *Lonchaea* spp.: 19, 20, and 21, holotype; 21, right lateral aspect of aedeagus; 22, 23, 24, and 25, holotype; 23, ventral aspect of apical segment of aedeagus; 25, right lateral aspect of aedeagus. Figs. 26 and 27. Ventral and right lateral aspect of male genitalia of *Dasyops dasyops* (Mg.), Potsdam.

Genitalia: The epandrium is longer in relation to its width; the cerci are smaller; the notch at the caudo-ventral aspect of the surstylus is much more pronounced and the apical segment of the aedeagus is nearly straight rather than spout-shaped (compare Collin 1953b, Fig. 17, and Hackman 1956, Figs. 45, 50 with Figs. 17 and 18 above).

In the female the sides of the frons are almost parallel. The lunule usually has 12 setulae. The third antennal segment is about twice as long as wide (2.7:1.3). The scutellum bears from three to five lateral setulae and usually two or three apically, in addition to the scutellar bristles.

Ovipositor (Fig. 34) as described by Collin (1953b, p. 200). I would add that the very short fine hairs on the penultimate section are not as long and do not extend as far caudad as in *L. deutschi* (compare Figs. 33, 34).

***Lonchaea hirticeps* Zetterstedt**

Figs. 4, 7, 19-21

Lonchaea hirticeps Zetterstedt, 1838, Ins. Lapp. 1:754; 1847, Dipt. 6:2357.

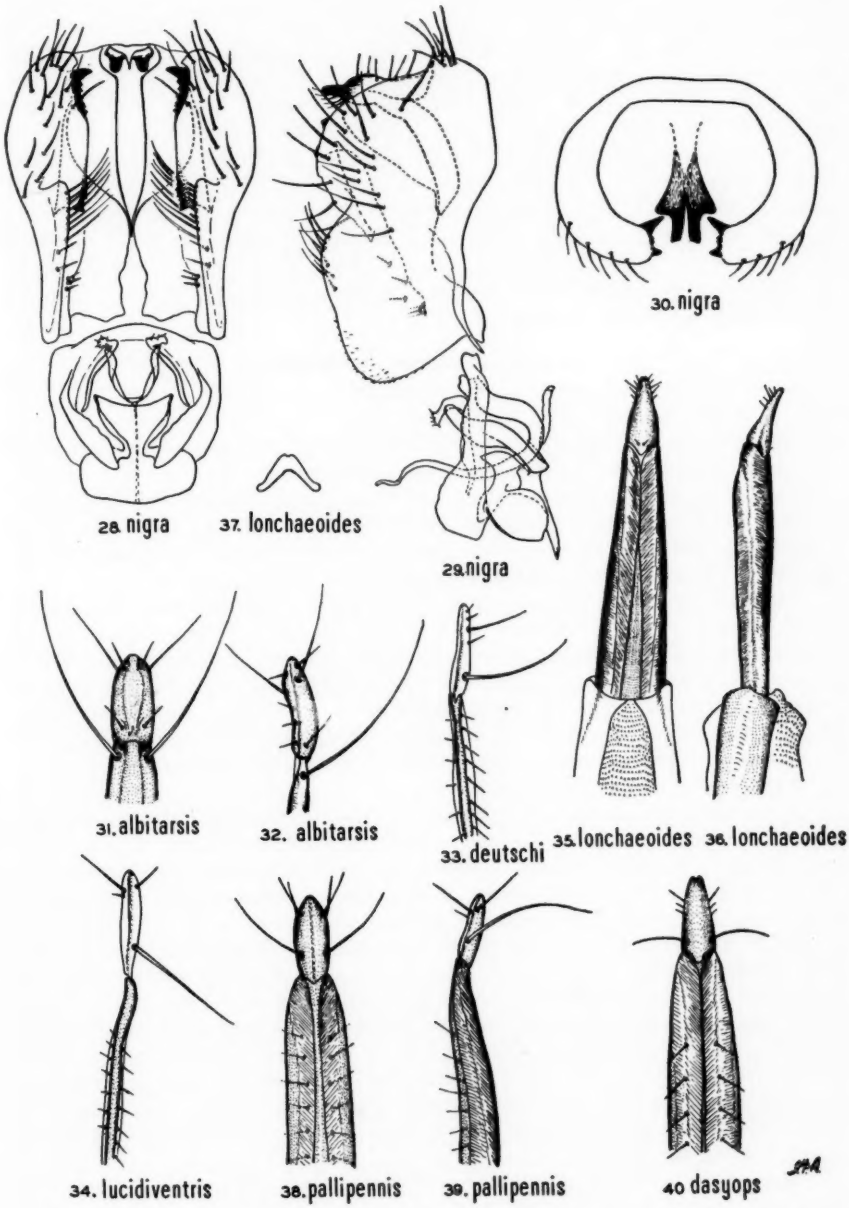
Specimen no. 388 in the Zetterstedt collection, Insecta Lapponica Section, is the holotype. It is labelled "*L. hirticeps.* ♂. Lycksele" and unquestionably is the male referred to in the original description (Zetterstedt, 1838) as follows: "*Hab. in Lapponia rariss.; ad Lycksele unicum individum inveni* (*Lapponia*)". The type is in good condition except that both third antennal segments are missing.

L. hirticeps Zetterstedt is a rather small, dullish black species similar to *L. deutschi* Zetterstedt. The tarsi, calyptrae, including margins and fringes, and wings are brown; the eyes are pubescent; the oral setulae are arranged in a single row; there are several hairs above the orbital bristle; there is a cluster of stigmatal hairs; there are several hairs caudad of the sternopleural bristle; the disc of the scutellum bears fine hairs; and the distance between the apices of *Sc* and R_1 greatly exceeds the maximum width of the costal cell. The species is included in the key under *L. deutschi* above.

It appears probable that there are several Palaearctic species closely related to *L. hirticeps* and that most authors have misinterpreted the nominal species. This is virtually certain for *L. hirticeps*, Collin (1953b) and Hackman (1956). All material standing under the name *L. hirticeps* should be reexamined.

Holotype, ♂, *Redescribed.*—Head about 1¼ times as wide as high (9.66:8.0). Frons (Fig. 4) somewhat wedge-shaped, but with narrowest part located at about two thirds of distance between anterior ocellus and lunule; proportions, slightly less than twice as long as wide (3.25:1.75); with dense, long hair i.e., the hairs distinctly longer than the oral setulae. Orbital plate with two or three setulae arising dorsad of orbital bristle. Orbital bristle arising further ventrad than anterior ocellus. Lunule (Fig. 4) with six, possibly eight setulae. Parafacial narrow, about as wide as combined diameters of two average-sized ommatidia; densely silvery pollinose. Cheek narrow (Fig. 7); with dense short hair. Oral setulae arising anterior to lowermost extremities of compound eye; rather weak; five or six in a single row (Fig. 7). Occipital setulae short; mostly slightly projecting beyond the compound eye, but dorsal three or four stronger. Compound eye with short pubescence, each hair nearly as long as the combined diameters of two ommatidia.

Mesonotum dark brown; with uniformly dull brown pollen; with thick, fine, moderately long hairs; bristles easily distinguished; several fine hairs caudad of posterior dorsocentral bristles and between postalar and postintra-alar bristles. Scutellum with four or five lateral setulae and five apical ones; disc with six



Figs. 28, 29 and 30. Ventral, right lateral and caudal aspects of male genitalia of "*Lonchaea*" *nigra* Mg. (=*parvula* Zett.). Figs. 31-34. Dorsal and right lateral aspects of ovipositors of *Lonchaea* spp. 31-32, syntype from Turtola – no. 384; 33, syntype from Juckasjervi; 34, Leipzig. Figs. 35-37. Dorsal, right lateral, and cross sectional aspects of ovipositor of *Earomyia lonchaeoides* Zett., lectotype. Figs. 38-40. Dorsal and right lateral aspects of ovipositors of *Dasyops* spp.: 38-39, holotype; 40, Potsdam.

hairs, the anterior ones arising slightly cephalad of a line joining lateral scutellar bristles. Epimeron with four or five stigmatal hairs. Mesopleuron hairy but without anterodorsal bristles; with five posterior mesopleural bristles. Notopleuron bare, except for two notopleural bristles. Sternopleuron with numerous long hairs on dorsal half, sternopleural bristle scarcely longer than adjacent hairs; four hairs arising caudad of sternopleural bristle. Pteropleuron bare.

Tarsi dark brown, but the two basal segments of all tarsi paler brown when viewed from below. Anteroventral series of hairs of hind femur without outstanding bristles. Wings distinctly brownish fumose as in *L. deutschi;* distance between apices of *Sc* and R_1 nearly twice as great as maximum width of costal cell (3.0:1.66). Calyptrae sandy-white, with dark brown margins and fringes.

Abdomen uniformly dusted with brown pollen, rather similar to *L. deutschi.*

Genitalia as shown in Figs. 19-21.

Lonchaea palposa Zetterstedt

Figs. 8, 22-25

Lonchaea palposa Zetterstedt, 1847, Dipt. Scand. 6:2385.

Specimen no. 389 in the Zetterstedt Collection, Diptera Scandinaviae Section – a male, bearing four labels: (1) white, "Nygrd. (?) 2/7.43", (2) orange-yellow. "178", (3) "*L. palposa* Staeg. ♂ Dania", and (4) green, "389", is the holotype. The original description refers to it as follows: "*Hab. in Dania rarissime*, D. Staeger, *qui specimen descriptum pro descriptione amice communicavit, cerca Hafniam 2 Jul.* 1943 *captum.*"

L. palposa Zetterstedt is a medium-sized species of *Lonchaea sens. str.*, similar to *L. polita* Say. The calyptrae and fringes are entirely pale; the tarsi are wholly yellow but somewhat darkened apically. There is one stigmatal bristle present. The palpi are very broad and elongate, projecting far beyond the oral margin; this character, alone, distinguishes the species from all others in the genus. It has many characters in common with the *scutellaris* group of species from which it differs mainly in specializations of the antennae and palpi and in the arrangement of the oral setulae.

Holotype, ♂, *Redescribed.*–Frons wedge-shaped; sides almost straight; proportions about 1¾ as long as wide (3.5:2.0); hairs fine and short. Orbital plate bare above the orbital bristle. Lunule orange-brown; with five setulae (it appears as if one, only, of the dorsal pair of setulae has developed). Parafacial narrower than width of two ommatidia; silvery pollinose. Oral setulae peculiarly arranged: (Fig. 8) no single row along the mouth margin, one hair, only, present dorsad of the usual genal hairs; with a rather dense cluster of bristly hairs on the lowermost extremities of cheek; with a vibrissa-like bristle in the midst of this cluster. Palpus greatly enlarged; longer, broader and more strap-like than third antennal segment but of the same general texture as the latter; with very fine, sparse hairs on the basal half of ventral margin; otherwise bare (in the sense that the third antennal segment is bare). Third antennal segment approximately twice as long as wide (2.9:1.5); distinctly reddish- or orange-brown at the inner base.

Mesonotum with distinct bluish reflections; hairs rather short, fine, and appressed; bristles easily distinguished; with several, fine hairs caudad of prescutellar row of bristles. Scutellum with four marginal setulae and two apical ones in addition to the usual scutellar bristles; lateral scutellar bristles arising about midway between anterior margin of scutellum and apical scutellar bristles. Epimeron with a single stigmatal bristle. Notopleuron with two notopleural bristles, otherwise bare. Mesopleuron with six posterior bristles, the ventral

two or three progressively weaker; without anterodorsal mesopleural bristles, although hairs present in this location. Sternopleuron with one bristle; no hairs caudad of this bristle.

Legs much as in the *L. scutellaris* group of species, i.e. front tibia silvery-yellowish anteroventrally near the apex, mid tibia with a rather strong apical ventral spine approximately as long as the greatest width of the tibia, hind tibia with a rather distinct, preapical dorsal bristle. Tarsi entirely yellow, the three basal segments paler than the apical two. Wings pale yellowish hyaline; veins pale yellow. Distance between *Sc* and R_1 distinctly less than maximum width of costal cell (1.9:2.25); apical portion of R_1 anteriorly convex, this greatly reduces the area of the stigmatal space of the subcostal cell and gives the illusion that the distance between the apices of *Sc* and R_1 is less than it actually is. Calyptrae white with pale yellowish margins and fringes.

Male genitalia as in Figs. 22-25.

Earomyia lonchaeoides Zetterstedt

Figs. 5, 9, 35-37

Earomyia lonchaeoides Zetterstedt, 1848, Dipt. Scand 7:2690.
Lonchaea crassinervis Zetterstedt, 1853, Dipt. Scand. 11:4333.

Specimen no. 394 in the Zetterstedt collection, Diptera Scandinaviae Section – a female bearing the label "*E. lonchaeoides* ♀ *a. Wadsten. Dbm.*" – unquestionably is the specimen referred to in the original description (Zetterstedt, 1848): "*feminam in fructibus prati Krogarängen prope Wadstena Ostrogothiae die* 13 *April*, 1832 *detegit Dahlbom*". I hereby designate this specimen as lectotype.

E. lonchaeoides Zetterstedt is a medium-sized, dull greyish-brown, weakly bristled species with very wide cheeks and parafacials (Fig. 9), entirely dark tarsi, brownish wings, and brown-fringed calyptrae. It is more heavily dusted with cinereous pollen than any other lonchaeid. The lunule (Fig. 5) is bare, the third antennal segment (Fig. 9) is nearly as broad as long, and the arista is ostensibly bare; the compound eye is sparsely pubescent. The epimeron has a single stigmatal hair. The mesopleuron has several antero-dorsally-directed hairs on the anterodorsal angle, the uppermost one bristle-like; there are five hair-like posterior mesopleural bristles. The sternopleuron has a dorsal row of setaceous hairs; the caudal one is strongest, the remaining four or five becoming progressively weaker cephalad. The scutellum has several lateral and apical setulae in addition to the usual scutellar bristles.

This distinctive species seems to have been correctly recognized by most authors. The Nearctic species resembling it most are *E. longistylata* McAlpine and *E. aquilonia* McAlpine (McAlpine 1956a). Both these species differ from it in having densely hairy eyes, a cluster of stigmatal hairs and many other definitive characters.

Lectotype, ♀, *Redescribed.*–Frons (Fig. 5) dull brown or silvery-grey (depending upon the angle from which it is viewed); approximately as broad as long (4.0:4.1); sides almost parallel. Frontal setulae in three rather distinct, vertically arranged series (Fig. 5) as follows: an irregular lateral row of inferior orbital setulae, an inner row of cruciate interfrontals, and a short intermediate series on each side between the inferior orbital and interfrontal series. Orbital plates bare above orbital bristle. Lunule (Fig. 5) covered with dense silvery scales; otherwise bare. Parafacials (Fig. 9) broader than ocellar triangle; densely silvery-grey pollinose. Cheek (Fig. 9) about half as high as height of compound eye; mostly cinereous pollinose but with a conspicuous polished area

immediately below compound eye, this area shiniest in the crescentic declivity adjacent to compound eye. Oral setulae (Fig. 9), seven or eight; latero-dorsally directed; in a single row. Third antennal segment (Fig. 9) about as broad as long (1.5:1.5); arista thickened on basal one-third. Antennal fovea deep; median facial carina distinct. Compound eye (Fig. 9) small, little higher than wide, with very sparse short hairs.

Mesonotum cinereous pollinose; ground colour blackish-brown; very feebly shining; moderately hairy above, the hairs rather erect but dorsal bristles easily distinguished. Scutellum cinereous pollinose; disc bare; a setula on each side between lateral and apical bristles, arising near the latter, and a pair of apical setulae between apical bristles. Lateral bristle arising about one-third of distance between base of scutellum and apical bristle. Epimeron with a single stigmatal hair. Notopleuron bare except for two notopleural bristles. Mesopleuron with two outstanding bristles near middle of posterior margin, and with three weaker ones alternating with them; anteriorly with several anterodorsally directed hairs, the two dorsal ones slightly stronger than the others. Sternopleuron with one outstanding bristle posteriorly, and with three or four progressively weaker hairs in front of it.

Legs and tarsi uniformly brown throughout. Front femur with numerous setaceous hairs posteriorly; mid femur with a posterior and a postero-ventral series consisting of about 12 setaceous hairs, these hairs strongest proximad, progressively weaker distad; hind femur without long hairs or bristles. Wings distinctly brownish fumose, especially adjacent to the longitudinal veins; venation plainly visible to the naked eye; veins dark brown. Distance between apices of *Sc* and R_1 distinctly greater than maximum width of costal cell (2.75:1.9). Costa much broadened at and beyond junction of R_1, i.e. at junction of R_1 as wide as length of anterior crossvein. Subcosta very weak, especially basal three-fourths. First anal vein extending as a weak fold to wing margin. Calyptrae whitish with light brown borders and darker brown fringes.

Abdomen feebly shining, blackish-brown; hairs long, erect, and bristle-like, especially at the margins of (apparent) segments three and four.

Ovipositor (Figs. 35-37) concave below and convex above, curving slightly dorsad and tapering to a sharp point; translucent brownish with a "varnished" appearance.

"*Lonchaea*" *crassinervis* Zetterstedt

Lonchaea crassinervis Zetterstedt, 1853, Dipt. Scand. 11:4333.

Specimens nos. 390, a male, and 391, a female, in the Zetterstedt collection are syntypes. No. 390 is labelled "*Lonch crassinervis* Ostr. Holmgren. ♂" and no. 391 has two labels, (1) "*Lonch crassinervis* Zett. ♀. Ostrog. Holmgn." and (2) "Winnrst. d. 20 Maj Pa' tradstramonor (?)". The following note accompanying the original description (Zetterstedt, 1853), clearly refers to these two specimens: "*Hab. in truncis arborum, ubi in paroec. Winnerstad Ostrogoth, utrumque sexum d.* 20 *Maj.* 1851 *detexit mecumque communicavit Clar. Holmgren.*"

"*Lonchaea*" *crassinervis* Zetterstedt is a junior synonym of *E. lonchaeoides* Zetterstedt as suggested by Czerny (1934). Both syntypes agree perfectly with the lectotype of *E. lonchaeoides* – even in the number of hairs on the scutellum. The frons of the male is narrower than that of the female; it is approximately 1 2/5 as long as wide (3.5:2.5). Unfortunately, the part of the abdomen with the genitalia is missing from the male syntype and I have no male specimens from which to illustrate these structures.

***Dasyops pallipennis* (Zetterstedt)**

Figs. 10, 11, 38, 39

Lonchaea pallipennis Zetterstedt, 1855, Dipt. Scand. 12:4786.

Specimen no. 393 of the Zetterstedt collection is a female bearing the label "*Lonch pallipennis* Zett. N.Sp. ♀. Öl. Holmgn." In addition there is a very small square of mauve paper inserted on the pin below the specimen. This piece of paper corresponds with a similar "marker" on the pin of the holotype of "*L. parvula* Zetterstedt, which was described at the same time as *pallipennis*. I believe that these little squares of paper indicate that the specimens were sent from Holmgren at the same time. Since the specimen of *parvula* bears the date 1852, it is virtually certain that specimen no. 393 is an 1852 specimen also and is, in fact, the holotype of *pallipennis*. Supporting this belief is the fact that Zetterstedt (1855) described the species from a single female and, concerning it, he stated as follows: "*versus finem Junii in Olandia ad Ottenby e que* D. Holmgren *specimen unicum femineum* 1852 *communicavit*." Czerny's (1934) report that the type no longer exists is an error.

Pallipennis is a member of the *dasyops* group of species. A combination of characters that will separate this group from all other lonchaeid groups is as follows: lunule bare; mesopleuron without antero-dorsal bristles; scutellum with one or more setula on the margin cephalad of each lateral bristle. In addition, all species in this group, including *pallipennis*, have very broad cheeks and parafacials (Fig. 10), multiserially arranged oral setulae (Fig. 10), deep antennal grooves, five or more posterior mesopleural bristles, and, so far as I have seen, they all have hairy eyes, three or more stigmatal bristles, whitish calyptrae with pale-yellow fringes, whitish wings and black tarsi.

The *dasyops* group includes several species in each of the Palaearctic and Nearctic regions and *pallipennis* may occur in both regions (see below). These species comprise a natural, compact, and easily defined taxon within the earomyiine lonchaeids, i.e., these Lonchaeidae with a bare lunule. In addition to the diagnostic characters given above, the male genitalia (Figs. 26, 27) are rather strikingly divergent from the usual form found in such species as *E. lonchaeoides*, *E. viridana* (Meigen), and *E. barbara* McAlpine; these structures in the *dasyops* group are most closely approximated by the type found in another easily defined group typified by *nigra* Meigen (Figs. 28-30). In view of these attributes I consider that the *dasyops* group is generically distinct from *Earomyia* Zetterstedt *sens. str.*, the type species of which is *E. lonchaeoides* Zetterstedt by monotypy.

Two generic names are available for the *dasyops* group, namely, *Dasyops* Rondani (1856) (misspelled "*Dasiops*" by Rondani), and *Chaetolonchaea* Czerny (1934). The type species of *Dasyops* Rondani is "*Lonchaea*" *dasyops* Meigen by monotypy and absolute tautonymy. The type species of *Chaetolonchaea* Czerny is "*Lonchaea*" *dasyops* Meigen by original designation.

The prevailing usage of "*Lonchaea*" *latifrons* Meigen as the type species of *Dasyops* Rondani (Enderlein, 1932; Hendel, 1932; Czerny, 1934; Hennig, 1948; and Collin, 1953b) is not in accordance with the Rules of Nomenclature. *Dasyops* was proposed by Rondani in 1856, and under it he cited "*loncheus mihi*" and "*dasiops* Mg". Although now considered a synonym of *latifrons* Mg., *loncheus* was not described and validated until 1874 (Rondani, 1874) and in 1856 it was only a *nomen nudum*. Thus, *Dasyops*, 1856, is monobasic for *dasyops* Mg.

Subjectively, it may be argued that Rondani (1856) misidentified *dasyops*

Mg. but positive evidence in support of this contention seems to be lacking[3]. Such being the case, the Rules state that the designation, indication, or selection of a species as type of a genus is not to be rejected on the ground that the original author of the generic name misidentified the species (Bulletin of Zoological Nomenclature, 1950, Vol. 4: pp. 158-159, Concl. 38; generalizing the decisions contained in Opinions 65 and 168; Copenhagen Decisions on Zoological Nomenclature, 1953, p. 68, par. 127).

Objectively, then, it is clear that the type species of *Dasyops* Rondani is *dasyops* Mg. and it follows that *Chaetolonchaea* Czerny is a junior synonym. Thus, the correct binomen for *pallipennis* is *Dasyops pallipennis* (Zetterstedt).

I have accepted Hennig's (1948) determination of *Dasyops dasyops* (Mg.) (Figs. 26, 27, 40) and have representatives of both sexes, collected at Berlin, Potsdam, and Riedel Urdingen, which Dr. Hennig very kindly identified and sent to me.

D. pallipennis is very similar to *D. dasyops* in general habitus and colour, but is distinctly smaller and less intensely bristled. The pubescence of the compound eye is much sparser and shorter, the inner and outer humeral bristles (Fig. 11) are very much weaker and shorter (in *D. dasyops* the three humeral bristles are subequal); there are five posterior mesopleural bristles (six in *D. dasyops*), and two sternopleural bristles, the anterior one weaker (three in *D. dasyops*, the posterior two subequal). The ovipositors differ as shown in Figs. 38, 39, 40.

The holotype of *D. pallipennis* keys to *Chaetolonchaea* (=*Dasyops*) *brevipilosa* Czerny (Czerny, 1934) and fits the description of that species in all respects; it is probable that *D. brevipilosa* is a synonym of *D. pallipennis*.[4] Female specimens of a *Dasyops* sp. from British Columbia, Alberta, Montana, and Colorado are indistinguishable from the holotype of *L. pallipennis* but possibly the males will show differences. It is possible that *Chaetolonchaea dasyops*, Collin (1953), may actually be *D. pallipennis*.

Holotype, ♀, *Redescribed*.—Frons subshining black; with sparse, short hairs in five pairs of rather distinct series on each half of frons: a complete lateral row of about 12, short, antero-mesally directed, inferior orbital setulae, a short inner row of about four cruciate interfrontals, and three intermediate rows of six to eight erect, longish, mesally directed hairs; several of the dorsal hairs of the intermediate rows arising opposite, but not dorsad of, base of orbital bristle; the cruciate interfrontal hairs antero-mesally directed, their apices overhanging the lunule; the same applying to the lowermost hairs of the inner intermediate series. Frons very little narrowed anteriorly; length from upper margin of lunule to anterior ocellus, less than width immediately above lunule (4.0:5:0). Lunule subshining black, not at all silvery; ptilinal scales shining black from all aspects. Parafacials very broad, at narrowest place, i.e., in the middle, slightly wider than distance between the posterior ocelli (1.5:1.4); shining black; pollen restricted to an extremely narrow area adjacent to the widest portion of the

[3]Since this paper was written Mr. Gunter Morge (*in litt.*), Humbolt-Universität zu Berlin, has informed me that he considers that Rondani misidentified specimens of *latifrons* Meigen as *dasyops* Meigen. Consequently the whole *dasyops* problem, involving spelling of the generic name *Dasyops* vers. *Dasiops*, and application of the generic name, has been placed before the International Commission on Zoological Nomenclature for interpretation and decision. In the interests of stability of nomenclature Mr. Morge has petitioned the Commission to suspend the rules, if necessary, concerning application of the generic name *Dasyops* (=*Dasiops*). Therefore both the spelling and application of the generic name as used here are subject to change, depending upon the decisions rendered by the Commission.

[4]Synonymy confirmed by Mr. Morge (*in litt*).

compound eye (Fig. 10). Cheek (gena plus subgena) very broad, in lateral aspect, (Fig. 10) about three-tenths as high as height of head (3.0:10.1); hairs multiserially arranged (Fig. 10). Hairs of compound eye very short and sparse relative to those on *D. dasyops* (Mg.) females.

Mesonotum black; coarsely setulose; with two setulae (one pair) arising between the base of the scutellum and the transverse row of strong mesonotal bristles; each of these arising on a longitudinal line passing between the dorsocentral and acrostical bristles. (on the right side a second weak setula arises very close to the larger one and I surmise that the number of setulae in the prescutellar area varies somewhat in this species; it is probable, however, that their position and average number is relatively constant; in *D. dasyops*, for instance, there are from 10 to 12 hairs in this area extending all the way across the prescutellar area). Marginal scutellar setulae arranged as follows: one or two (one on right side, two on left) cephalad of lateral scutellar bristles, two between the lateral and apical bristles and none between the apical bristles. (all members of the *D. dasyops* group seen have the scutellum bare between the apical bristles). Humerus (Fig. 11) with one strong median bristle (mh); inner humeral (ih) barely half as long as median one; outer humeral (oh) hair-like. Notopleuron with several setulae on extreme dorsal margin (Fig. 11), otherwise bare on disc except for the usual pair of notopleural bristles. Mesopleuron with five strong posterior bristles and three progressively weaker hairs in the same series ventrad of the bristles; without anterodorsal bristles, the setulae in this area (caudad of the mesothoracic spiracle) very short. Stigmatal bristle accompanied by six setulae. Sternopleuron with two bristles, the anterior one weaker; with two hairs above and between these bristles but with none caudad or ventrad of them.

Legs and tarsi black; hind femur with three anteroventral bristles. Wings creamy-yellowish with darker yellowish veins; black setulae of costa extending to a point about one-third of distance between apices of R_{2+3} and R_{4+5}; distance between apices of *Sc* and R_1 greater than greatest width of costal cell (2.0 : 1.6).

Abdomen coniform as in *D. dasyops*. Ovipositor (Figs. 38, 39) shorter and less polished than in *dasyops;* dorsal aspect with a distinct constriction between the main shaft and the apical section. Apical section more or less rectangular with gently convex side; and obtusely angled apex; hairs near base of dorsal side longer than apical section; subapical dorsal hairs shorter, subequal to subapical ventral pair. [In *D. dasyops* the apical section of the ovipositor (Fig. 40) is gradually tapered from base to an emarginate apex; the hairs near the base on the dorsal side are shorter than the apical section and the subapical dorsal hairs apparently are absent].

"Lonchaea" parvula Zetterstedt

Figs. 6, 28-30

Lonchaea parvula Zetterstedt, 1855, Dipt. Scand. 12:4785-6.

Specimen no. 392, of the Zetterstedt collection, a female bearing the label "*Lonch parvula* Zett. n. sp. ♀ 01. 1852, Holmgren.", is the holotype. Zetterstedt (1855) described the species from a single female and referred to it as *ad Ottenby Olandiae meridionalis versus finem Junii* 1852 *ab* E. A. Holmgren *inventa*".

"*L.*" *parvula* Zetterstedt is a junior synonym of *Lonchaea* (*sensu lato*) *nigra* Mg. (Figs. 6, 28-30), as suggested by Czerny (1934). The holotype is an extremely small specimen with most of the abdomen missing, but the following characters leave no doubt concerning its identity; Lunule bare; third antennal

segment short; cheek and parafacial narrow; oral setulae, seven or eight, in a single row; compound eye bare; each side of vertex with three or four mesally directed postocular setulae caudad of the outer vertical bristle and another such setula caudad of, and between the inner vertical bristle and the postocellar setula. (All these characters illustrated in Fig. 6). Prescutellar region of mesonotum (between the base of the scutellum and the transverse row of strong mesonotal bristles) bare; dorsocentral row of bristles strong, i.e., six easily distinguished bristles in each row; scutellum with the usual four scutellar bristles, otherwise bare; antero-dorsal mesopleural bristle absent; with three strong posterior mesopleural bristles, and one humeral bristle; epimeron with one stigmatal hair; sternopleuron with two strong sternopleural bristles and one weak setula in front of them. Wing milky-white; calyptrae white with pale yellow margins and fringes. Tarsi entirely black.

Acknowledgments

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[5]Dr. Lindroth has informed me that the specimens sustained severe damage in the mail while enroute to the Zoological Institute, Lund.

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The Ant *Lasius alienus* (Foerster) Parasitized by the Fungus *Laboulbenia formicarum* Thaxter at London, Ontario

By W. W. JUDD[1] and R. K. BENJAMIN[2]

During the summer of 1957, collections of insects from burrows of the woodchuck, *Marmota monax*, were made by the senior author in the vicinity of London, Ontario. The collector obtained the insects by reaching into a burrow for a distance of about one yard and scraping out by hand the loose soil at the bottom of the burrow from the outer one yard of the length of the burrow. The accumulation of soil and debris thus obtained was combed over and insects were removed from it. By this method insects were collected from thirty burrows, and these were sorted according to order and family and sent to taxonomic specialists for identification.

Among the insects collected were several specimens of the ant, *Lasius alienus* (Foerster), identified by M. R. Smith, Agricultural Research Service, U.S. Department of Agriculture. Nesting in soil or under cover, this species, according to Muesebeck *et al* (1951), is one of the most common and widely distributed of North American ants. Several specimens of *L. alienus* from four burrows were found to be parasitized by the fungus, *Laboulbenia formicarum* Thaxter. These specimens were as follows: 8 workers from burrow no. 3, in a field adjacent to the south-west corner of Highbury Avenue and the fourth concession of Township of London, June 12; 1 worker from burrow no. 4 in the same locality as no. 3, June 12; 4 workers from burrow no. 16 in fields adjacent to the south bank of the south branch of the Thames River just west of Meadowlily Road, Township of Westminster, June 26; 6 workers from burrow no. 17 in the same locality as no. 16, June 26. The two collection localities are five miles distant from one another, the first being north-east and the other south-east of the city of London. Some of the specimens collected are retained in the collection of the junior author (RKB 2054 from burrow no. 3; RKB 2055 from burrow no. 16; RKB 2056 from burrow no. 17), and the remainder is in the collection of the Department of Zoology, University of Western Ontario.

Laboulbenia formicarum has not been recorded previously from Canada although it has been reported from several localities in the United States (Smith, 1946), and twenty species or varieties of ants representing four genera, *Lasius*, *Formica*, *Prenolepis*, and *Polyergus*, are known to harbor this parasite. This fungus is of especial interest because it is the only species of *Laboulbenia*, a genus of over 400 described species, which is known to be dioecious (Benjamin and Shanor, 1950).

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(Received January 23, 1958)

Observations on Predation by the Plant Bug *Liocoris borealis* Kelton (Hemiptera: Miridae)[1]

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In the laboratory it was observed that the plant bug *Liocoris borealis* Kelton occasionally attacked its predator, an assassin bug, *Sinea diadema* (F.) (Reduviidae), when the nymphs of *S. diadema* were immobilized during moulting. During an experiment seven out of 35 predators were killed by their intended prey. It is probable, however, that others were also killed, for only seven reached the adult stage.

Riley (1872, p. 20) reported that in Missouri there was inconclusive evidence that the tarnished plant bug, *Liocoris lineolaris* (Beauv.) (= *Lygus pratensis* (L.)), fed on larvae of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). Recently Kaczmarek (1955) also listed *L. pratensis* as an important predator of this pest of potatoes. Sherman (1921) observed that during an outbreak of the fall cankerworm, *Alsophila pometaria* (Harr.), in forests of the southern Allegheny Mountains of North Carolina, one or more species of *Lygus* were abundant and several were seen with cankerworms impaled on their beaks. Petherbridge and Thorpe (1928) noticed an apparent inverse relationship between the numbers of the green capsid bug, *Lygus pabulinus* (L.), and the severity of infestation of the aphid *Hyperomyzus lactucae* (L.) (=*Amphorophora cosmopolitana* Mason) on bushes. Knight (1923) wrote: "The predaceous habit is only partially developed in certain species [of Miridae] and thus animal blood serves merely to supplement the sap obtained from particular food plants."

The predatory habit in *L. borealis* was examined by confining nymphs of various instars from fresh alfalfa clippings with the pea aphid, *Acyrthosiphon pisum* (Harr.). No plant material was added to the containers and high humidity was maintained with moistened blotting paper.

Within five minutes after the introduction of the first group of fourth-instar nymphs of *L. borealis*, three had commenced feeding on aphids. They held their prey with their fore legs and quickly inserted their beaks, with no apparent discrimination as to location of insertion; sometimes the beaks were thrust in, with a sawing motion, almost to the tips of the labra. As the plant bugs fed, the victims' bodies became sufficiently transparent for the probing beaks to be seen within. Except one third-instar nymph that fed briefly on a moribund aphid, only fourth- and fifth-instar nymphs were observed to feed on aphids; one-third of the nymphs from these two late-instar groups reached the adult stage. After maturity the adults lived up to one week on a diet consisting only of aphids.

These observations and literature references indicate that in plant bugs the entomophagous habit is not too widely separated fom the phytophagous. This further complicates the study of faunal interrelations in crops such as alfalfa. It is probable that other species of *Liocoris* and *Lygus* are sometimes predatory; under certain conditions, therefore, they could assist in reducing large populations of aphids appreciably, as they are usually more prevalent in alfalfa fields than most of the common predators. This effect might be more evident as the plants become less succulent. Though it would be difficult to

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estimate the value of plant bugs as predators, it does pose a problem worthy of further study.

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Host Susceptibility to Paralysis by the Tick *Dermacentor andersoni* Stiles (Acarina: Ixodidae)[1]

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One of the objectives in the study of tick paralysis at Kamloops was to discover a species of laboratory animal that is consistently susceptible to this disease. Such an animal was needed to explore inconsistencies probably caused by differences in tick virulence or host susceptibility. Observations on infestations of adults of *Dermacentor andersoni* in tick paralysis areas in British Columbia, and experiments with similar ticks on large and small wild and domestic animals, have revealed the following.

Generally, large wild animals appear to be resistant to tick paralysis. Small numbers of *andersoni* have been taken from several mule deer, *Odocoileus h. hemionus* (Rafinesque), and heavy concentrations of the tick occur in certain of their haunts, suggesting that they play a considerable part in feeding the adults. However, although deer and moose are frequently killed by the exsanguinating effect of heavy infestations of *D. albipictus* (Packard), none has been known to suffer from paralysis caused by *andersoni*. Nor has the disease been observed in Rocky Mountain sheep and goats, *Ovis c. canadensis* Shaw, and *Oreamnos americanus missoulae* (Allen), both of which are hosts of *andersoni* in southeastern British Columbia. Indeed, the only record of a native ungulate being paralysed by the tick is that of wild buffalo, *Bison b. bison* (Linnaeus), in Montana (Kohls and Kramis, 1952). Bears, *Ursus* sp., have been found infested with small numbers of *andersoni* without showing ill effects. Porcupines, *Erethizon* sp., commonly frequent areas heavily populated by *andersoni* and on a number of occasions have been found to be very heavily infested with engorged females. They also appear resistant to paralysis.

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On the other hand, large domestic animals appear to be relatively susceptible to tick paralysis. A 1000-pound bull and a mature steer were found paralysed by single ticks. Usually, however, cattle do not become affected by fewer than a dozen ticks and often they may feed a hundred or more without ill effects. Yearlings appear to be affected more than calves or cows.

Although observations have shown that horses are not readily infested by *andersoni* three were found paralysed by solitary ticks. Davidson (1941) also reported the deaths of four yearling colts, and the paralysis of another by about 500 ticks at Webb, Saskatchewan.

Sheep and dogs, although apparently more susceptible to tick paralysis than cattle, show a marked variation in their reaction to engorging ticks. On a number of occasions paralysis was produced by infesting these animals with only one or two ticks. On other occasions infestations of as many as 60 pairs of ticks failed to produce symptoms; subsequent paralysis, caused by fewer ticks, removed the possibility of immunity in some of these instances.

A cat infested with 10 females of *andersoni* for seven days and a pig infested with six pairs that fed to repletion did not become paralysed. No other tests were made with these species.

Man appears to be particularly susceptible to tick paralysis and, weight for weight, appears to be more sensitive to tick toxin than any other species. In about 250 case histories of the disease in British Columbia, of which 28 terminated fatally, only one female tick was involved in each. Indeed, only seven ticks of the size usually involved in paralysis of humans (60-150 mg.) were recorded as not having caused symptoms of paralysis, although admittedly such asymptomatic occasions are less likely to be reported.

Small laboratory animals appear to be highly resistant to tick paralysis. Large numbers of *andersoni* were fed on guinea pigs during spotted fever studies at Kamloops without the host becoming paralysed. Numbers of adult ticks have been fed to repletion on rabbits without paralysis occurring. Neither do white mice appear to be paralysed by *andersoni,* and all of 17 animals were unharmed by individual females feeding on them for at least seven days. Two others tolerated four and six females. When infested with individual mated fast-feeding[3] females, 15 of 19 mice died when the ticks reached repletion. However, there was no paralysis, and blood pictures suggested that these deaths were due to anaemia. The only packrat tested was unharmed by one of *andersoni* which engorged to repletion.

Little thought was given to the effect of *andersoni* adults on native groundhogs, *Marmota flaviventris avara* (Bangs), and groundsquirrels, *Citellus c. columbianus* (Ord), because, although they are well known hosts of the immature stages of this tick, adults had not been taken from them in collections. Nevertheless, during control studies of the tick it was necessary to determine the possible part played by these animals in feeding adult ticks and so maintaining the ticks in areas where they were otherwise controlled by sprays on cattle. It was discovered that *andersoni* females not only feed on groundhogs and groundsquirrels, but affect them with paralysis of the limbs about the fifth day after attachment. After this the animals usually became weak, lost their voices, and died within 12 to 24 hours. When the ticks were removed, recovery was slow (12-36 hours) and uncertain.

Of eight groundhogs (all adult but the eighth) on which unengorged female ticks were placed, all were paralysed, as follows:—

[3]Mating increases the feeding rate of females of *D. andersoni* (Gregson, 1944).

1. Paralysed and killed 6 days after infestation by 2 females (108, 45 mg.[4]).

2. Paralysed and killed 6 days after infestation by 5 females (each about 150 mg.).

3. Paralysed and killed 7 days after infestation by 2 females (7, 160 mg.).

4. Paralysed and killed 5 days after infestation by 2 females (29, 30 mg.).

5. Partially paralysed 5 days after infestation for 2 weeks by 1 female (45 mg.).

6. Paralysed and killed 5 days after infestation by 9 females (50 to 150 mg.).

7. Paralysed 5 days after infestation by 8 females; killed for observation.

8. Paralysed 5 days after infestation by 4 females; ticks removed before paralysis became severe; slow recovery.

Except for No. 8, the ticks were removed only when the host had become severely paralysed. Tests were made for Colorado tick fever, Q fever, and tularaemia in the first four instances but nothing infectious was found in either the ticks or their hosts. Of three adult groundsquirrels, on which eight, four, and eight, unengorged female ticks were placed, all were paralysed and died by the fifth day, at which time each tick weighed about 150 mg.

The discovery that groundhogs and groundsquirrels are apparently highly susceptible to a tick factor that causes paralysis permitted further studies to be made on the relationship of tick and host to this disease. To ascertain whether the usual "conditioning" period of five to six days associated with tick paralysis is due to a factor within the host or within the tick, the nine half-fed ticks that had paralysed ground hog No. 6 were transferred to a young groundhog (No. 9). They reattached and caused paralysis within 17 hours. Transferred to another adult groundhog (No. 10), they caused paralysis within 36 hours. Both animals recovered about 36 hours after removal of the ticks, but four days later No. 10 relapsed and died. When animals Nos. 8 and 9 were infested with 10 more females each, they became paralysed again and died during the fourth and fifth day of infestation. As with dogs and lambs, immunity is apparently not conferred by the initial paralysis. These observations suggest that the production and timing of paralysis in a susceptible host depend on the condition of the feeding tick.

An effort was then made to produce paralysis in groundhogs by injecting extracts from ticks that had fed for several days. Secretions, collected *in vitro* from partially fed ticks (Gregson, 1957), seemed a logical source of toxin, but 0.2 cc., which had been pooled from about 50 ticks immediately after their removal from a sheep, and kept on ice, failed to produce any noticeable response when injected subcutaneously into a 380-gram young groundhog. After this, 0.2 cc. of salivary glands from 30 similar ticks were ground in alundum with 0.1 cc. of 0.75 saline and centrifuged and 0.2 cc. of the supernatant fluid was injected subcutaneously into a 365-gram goundhog. The animal soon became listless, scratched, and kept changing its position; two hours later it whined; within another hour it collapsed and died. Attempts to repeat the condition in two larger groundhogs with a weight-volume dosage slightly less than that of the original produced only listlessness and sudden scratching about three hours after the injection.

Intravenous and subcutaneous injections into six white mice at weight-volume dosages up to three times that lethal to the groundhog failed to produce

[4]Unfed females of *D. andersoni* weigh 4 to 6 mg. After five days of feeding, when paralysis is most likely to occur, they weigh 60 to 150 mg. Fully engorged females weigh up to 700 mg.

symptoms. Their resistance to the toxin probably explains earlier failures to duplicate experiments of Ross (1935), who demonstrated that in Australian tick paralysis the injected glands of two and one half ticks were lethal to mice.

It is usually considered that hosts may develop a tolerance to parasites that have long been associated with them. This may account for the lower response to tick paralysis by wild animals than by domestic ones and man. The apparent susceptibility of groundhogs and groundsquirrels to ticks, however, is an exception. Although neither this condition nor infestations by adults of this species of tick have been observed in nature in British Columbia, such probably occur. The animal is an important host for both the larvae and nymphs of the tick and heavy concentrations of the adult stages occur at most groundhog colonies. It is assumed that animals so afflicted would probably avoid detection by remaining underground. The automatic effect of the tick in depriving its progeny of a natural host offers interesting speculations on the relationships of both parasite and host to their respective populations. Studies of the disease in groundhogs are being continued to determine its relationship to tick paralysis of larger animals.

Summary

Large wild animals, buffalos in one instance excepted, appear to be resistant to tick paralysis. Large domestic animals are relatively susceptible, man appearing to be the most sensitive. Laboratory rabbits, guinea pigs, and mice all appear to be highly resistant to tick paralysis. Groundhogs and groundsquirrels, however, may be readily paralysed and killed by small numbers of female ticks. The condition was also produced in a groundhog by a subcutaneous injection of crushed salivarly glands of feeding ticks.

Acknowledgments

The writer is indebted to officers of the Rocky Mountain Laboratory, Hamilton, Montana, for making the tests for Colorado tick fever, Q fever, and tularaemia.

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A Method of Rearing Bark- and Cambium-Feeding Beetles with particular Reference to *Hylobius warreni* Wood (Coleoptera: Curculionidae)[1]

By G. L. WARREN[2]

Introduction

Hylobius warreni Wood is a recently described weevil that was originally confused with *Hypomolyx piceus* (DeGeer) (Wood, 1957). The larvae attack the inner bark and cambium of the root system of jack pine, *Pinus banksiana* Lamb., and other conifers (Warren, 1956). The life history of this insect is being studied to determine biological differences between it and a closely related species, *Hylobius pinicola* (Couper). This information is also essential in order to continue detailed studies on the effect of site and other factors on the abundance of *H. warreni* (Warren, 1956a). The first requirement for fulfilling these objectives is the development of a satisfactory rearing technique.

Insects that feed subcortically are difficult to rear without sacrificing essential data on the number of moults or on developmental periods of various stadia. Taylor (1930), Kaston and Riggs (1937), Forbes (1953), and others recognized this difficulty, and estimated the number and duration of larval stadia from head capsule measurements and the periodic frequency of size groups. The writer investigated these techniques for *H. warreni* but found them unsatisfactory because head capsule sizes did not fall into discrete groups. It became apparent that there is no satisfactory alternative to rearing for following the development of stages. Three rearing media were used. One was simply moistened absorbent cotton and was used for rearing eggs. The other two are described below as "Bark Homogenate" and "Whole Bark". "Bark Homogenate" was particularly useful as a substrate for transporting larvae from the field and for rearing pupae. It was not satisfactory for rearing eggs and larvae. "Whole Bark" was used exclusively as a larval rearing medium.

Preparation of Media

Before the insect could be reared it was necessary to devise a medium upon which larvae would feed and develop. Also the larvae had to be either visible or easily available for frequent inspection in order to satisfy the requirements of life history studies. Two types of media were prepared as follows.

1. Bark Homogenate

Bark was stripped from the roots of living host trees. The fresh bark was minced with a household blender, using just enough distilled water to facilitate cutting. Granulated agar was added at the rate of 4 per cent of the weight of water required to mince the bark. These materials were then stirred continually while heating to 80°C., ladled onto unglazed paper to remove unabsorbed water, and packed in sterilized glass preserving sealers for storing. When the medium cooled to room temperature it formed a homogeneous mash. The growth of mould and bacteria in the stored medium was prevented by the heating and by filling the containers to their capacity immediately prior to sealing them.

2. Whole Bark

The preparation of this medium was similar to that described by Bedard (1933) and Kaston and Riggs (1937) for rearing bark beetles. Bedard cut out a

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section of bark containing a colony of bark beetles and placed it between two pieces of glass, which were held together by elastic bands. He then packed moistened absorbent cotton around the bark to keep it from drying. Kaston and Riggs used essentially the same method, but substituted a wooden press for the elastic bands. They considered that Bedard's method was inadequate because elastic bands were not strong enough to hold the glass plates tightly against the bark. However, they experienced difficulty with their own technique which caused excessive breakage of glass within the press. In testing their procedure the author had difficulty in maintaining moisture by the simple expedient of packing loose absorbent cotton around the bark. The preparation described below was devised to overcome the difficulties of earlier investigations.

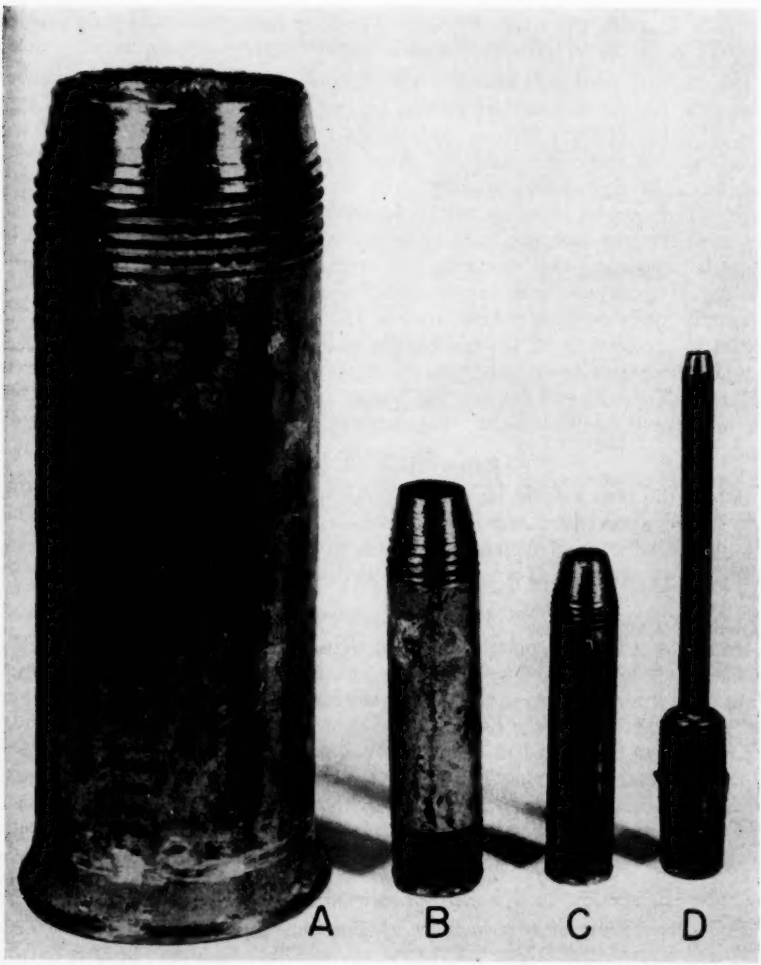

Fig. 1. Punches 1 1/2, 1/2, 3/8, and 1/8 inches in diameter. A, B, and C are sharpened galvanized pipe nipples; D is a sharpened Coleman gas lamp generator.

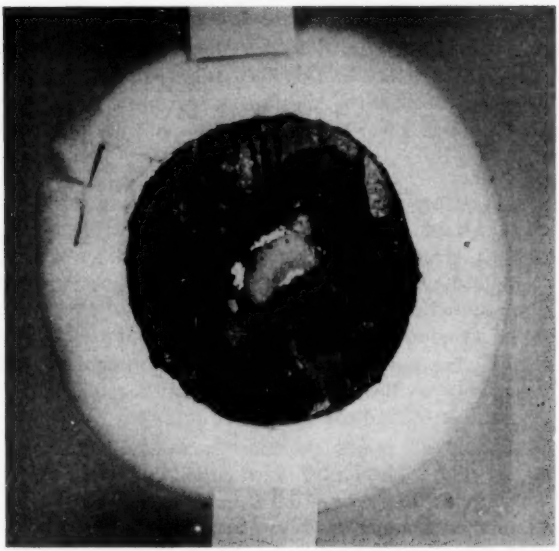

Fig. 2. A "whole bark chamber" containing a feeding larva of *H. warreni.*

Cores of outer and inner bark, to which some cambial tissue was still attached, were cut from the roots or root collars of living host trees. The cutting was done with a punch which was made by sharpening a 1 1/2-inch pipe nipple (Fig. 1A). The outer bark of the cores was shaved to thicknesses varying from 1/8 to 3/8 inches, depending on the size of the larvae to be accommodated. Centre holes were cut in the cores with punches (Fig. 1) varying from 1/8 to 1/2 inches in diameter. Each hole was made just large enough to accommodate the larva to be reared. A 6-inch strip of No. 2 dental cotton was stapled to form a ring (Fig. 2), moistened by dipping in distilled water, and then placed on a 3-inch square of window glass. A prepared core of bark was placed inside the cotton ring and a larva inserted in the centre hole. Another 3-inch square of glass was used as a cover and the two glass slides held together firmly by applying two strips of 1/2-inch waterproof plastic tape[3] (Fig. 2). The assembled components formed a larval rearing chamber.

Rearing Procedure

Reared or field collected eggs were incubated on moist cotton in 60 mm. petri dishes.

When the larvae hatched from the eggs they were placed in whole bark chambers to complete their development. During this period they were observed every 1 to 3 days to determine the number of moults and the duration of larval stadia. Food was renewed and moisture replenished as required. Each chamber was quickly moistened by holding it vertically and dipping it in distilled water to a depth required to cover the bottom of the wick-like absorbent cotton ring. The chamber was then reversed and dipped in a similar manner.

Most of the larvae of *H. warreni* were not reared from eggs but were collected from host trees. These larvae were immediately placed in 60 mm.

[3]"Curad Plastic Adhesive Tape" and "Scotch Brand 33 Plastic Tape" were the most suitable types tested.

petri dishes that had previously been filled with bark homogenate. This protected the larvae from desiccation during transfer to the laboratory where they were then placed in whole bark chambers.

When the larvae reached the prepupal stage they were transferred from whole bark to bark homogenate until the termination of the pupal period.

Discussion

Eggs failed to hatch on bark homogenate but some success was obtained on moistened cotton. However, these rearings required frequent observation because newly hatched larvae had to be transferred to food within a day to avoid high mortality. Although it may be possible to rear eggs on whole bark, which would provide an immediate food source for larvae as they hatched, this has not been attempted because of the difficulty in obtaining eggs of this insect.

Larval rearings were not satisfactory in bark homogenate. Although they appeared to feed readily on this medium, they soon became embedded in it, and it was usually impossible to find the exuviae.

The whole bark medium was the most successful one devised for rearing the larvae of *H. warreni*. The larvae were either completely visible at all times or could easily be traced and removed for examination from their well defined tunnels. They resumed feeding readily when provided with a fresh supply of food. There was very little mortality of larvae reared in this medium. Some larvae, especially small ones, were killed while extracting them from their tunnels for the periodic examination required for life history studies.

Poor results were obtained from attempts to rear pupae in whole bark chambers. The difficulty arose from the inability to differentiate between feeding larvae and prepupae. Feeding larvae prepare pupal cells and if the food is changed at this time they pupate in incomplete cells. This condition caused high mortality of pupae and was overcome by transferring late last-instar larvae to bark homogenate for pupation.

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A New Species of *Typhlodromus* Scheuten, 1857 (Acarina: Phytoseiidae), with Notes on Life-histories and Food Habits of *Typhlodromus* sp. n. and *T. tiliae* Oudms.

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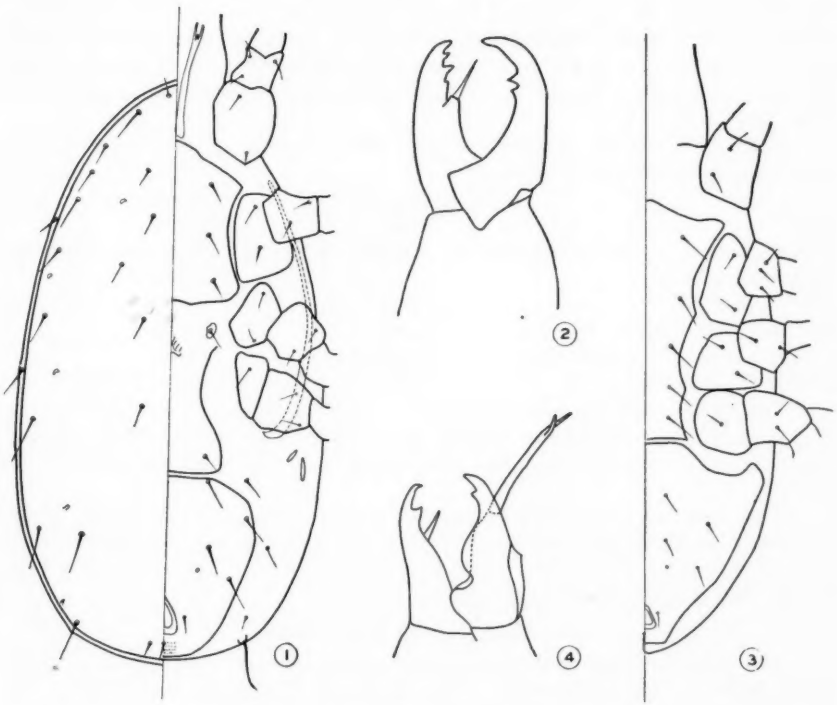
The following is a description of a new species of predacious mite of the subfamily Phytoseiinae. It is found in orchards in Nova Scotia on the bark of apple trees, but in no instance has it been taken from the foliage. This species is similar in structure to *Typhlodromus tiliae* Oudmus. (Nesbitt, 1951), but its habits differ. In this paper the differences between *T. tiliae* and the species herein described are noted and details of a laboratory study of the life-histories and food habits of these species are given.



Description of *Typhlodromus corticis* sp. n.

Female.—Dorsal plate .37 to .40 mm. long and .20 to .24 mm. wide. Dorsum mildly imbricate and bearing 17 pairs of setae of variable lengths. Anterior lateral setae shorter than the distance between their bases. Seta M 2 close to L 8. Dorsum with five pairs of distinct pores or markings, one mesad of L 4, one posterad of L 5, and one posteromesad of L 6, one anterad of the pair M 2 and L 8, and one anterad of L 9. Setae S 1 and S 2 on interscutal membrane

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laterad of dorsal plate. One large and one small parapodal plate. The short peritremal plate extending from base of coxa of leg IV anteriorly to base of coxa of leg I (Fig. 1). Sternal plate characteristic in shape and the ventrianal plate bearing four pairs of pre-anal setae and a pair of pores (Fig. 1). The fixed member of the chelicera with three teeth distally and the movable digit with two (Fig. 2).

Male.—Smaller than female. Dorsal plate .30 to .32 mm. long and .17 to .20 wide. Chaetotactic pattern of dorsal plate similar to that of the female except that S1 and S2 are on dorsal plate instead of the interscutal membrane. Ventrianal plate bearing four pairs of pre-anal setae and a pair of pores (Fig. 3). The fixed digit of the chelicera bearing one tooth distally and the movable digit one tooth in addition to the hammer-shaped spermataphore (Fig. 4).

Type Habitat.—Bark of trunk of apple tree, Starr's Point, Nova Scotia.

Types.—The holotype, a female, and the allotype, a male, were reared in the laboratory from an overwintered female collected on the bark of an apple tree trunk at Starr's Point, N.S., April 4, 1956. Four paratypes were collected from this locality on the same date. These type specimens are in the Canadian National Collection (No. 6591). Other specimens are preserved at the Kentville laboratory.

Notes.—*T. corticis* approximates *T. tiliae* Oudms. They differ in the following characteristics:

	T. corticis	*T. tiliae*
Size	Larger	Smaller
Dorsal plate of overwintered female	.37 to .40 mm. long	.31 to .34 mm. long
Egg, newly laid	.021 mm. long	.018 mm. long
Pits on dorsum	5 pairs	4 pairs
Pits on ♀ anal plate	1 pair	None
Pre-anal setae of ♂ anal plate	4 pairs	5 pairs
Pits on ♂ anal plate	1 pair	None

The dorsal setal arrangement is similar in the two species but the setae of *T. tiliae* are longer and more heavily sclerotized. The dorsum of *T. tiliae* is more heavily sclerotized and the imbrications are more definite than on *T. corticis.*

Ten males of *T. corticis* were each paired with a female of *T. tiliae*, and ten males of *T. tiliae* were each paired with a female of *T. corticis.* None were observed copulating nor did any of the females lay eggs until after they mated with a male of the same species.

Life-histories and Food Habits

The progeny from five overwintered females of each species were reared individually in capsules (Herbert, 1956) at 70±2° F. These were divided into lots of 17 to 75 males and females per test. In each of four series of tests the predators were given the following daily: (a) eight larvae of *Bryobia praetiosa* Koch; (b) 20 eggs of *Tetranychus telarius* (Linn.); (c) five eggs of *B. praetiosa;* (d) five eggs of *Metatetranychus ulmi* (Koch). Also, in two series only, *T. corticis* was given the following daily: (a) eight larvae of *B. praetiosa* and 20 eggs of *T. telarius;* and (b) eight larvae of *B. praetiosa* in the sub-adult stages and 20 eggs of *T. telarius* only in the adult stage.

The mites were inactive and fed little, if any, in the larval stage, which lasted about one day for each species. After the mites became protonymphs they became active and fed voraciously. The males and females of both species

TABLE I

Average durations (days) of nymphal stages and of lives* of males and females of two predacious species, and total numbers of prey consumed by individuals, when various prey were provided in laboratory

	T. tiliae		*T. corticis*		
	Duration of stage	No. prey consumed	Duration of stage	No. prey consumed	
Byrobia praetiosa larvae					
Protonymphs	3.7	25	7.7	43	
Deutonymphs	3.2	22	6.0	34	
Males	44	264	98	435	
Females	144	853	91	480	
Tetranychus telarius eggs					
Protonymphs	4.6	92	11.4	151	
Deutonymphs	5.4	74	—	—	
Males	59	833	—	—	
Females	95	1550	—	—	
B. praetiosa larvae and *T. telarius* eggs				Larvae	Eggs
Protonymphs	—	—	7.0	40	84
Deutonymphs	—	—	7.0	40	84
Males	—	—	70	314	671
Females	—	—	74	397	784
B. praetiosa eggs					
Protonymphs	8.4	14	5.2	13	
Deutonymphs	4.0	8	6.6	16	
Males	—	—	30	46	
Females	35	57	—	—	
Metatetranychus ulmi eggs					
Protonymphs	4.6	18	7.8	36	
Deutonymphs	3.7	16	5.2	26	
Males	13	36	34	108	
Females	66	200	52	190	

*From hatching until death.

pass through one larval and two nymphal stages before becoming adults. Table I shows that nymphal periods were shorter for *T. tiliae* than for *T. corticis* except when the species were given eggs of *B. praetiosa.* When the protonymphs of *T. corticis* were fed eggs of *T. telarius* they did not develop to deutonymphs, although several individuals lived over 30 days. When the diet of *T. corticis* was composed of *B. praetiosa* larvae and *T. telarius* eggs the nymphal stages were about as long as when the diet was composed of *B. praetiosa* larvae only.

Males and females of *T. corticis* differed little in duration of life, from hatching until death, but *T. tiliae* females lived considerably longer than the males (Table I). Although *T. tiliae* females lived longer when fed larvae of *B. praetiosa* than when fed eggs of *T. telarius,* males fed on these prey differed little in duration of life. *T. corticis* males and females lived longer on larvae of *B. praetiosa* than on the larvae of *B. praetiosa* and eggs of *T. telarius.* Males and females of *T. corticis* fed on larvae of *B. praetiosa* in the sub-adult stage and then given eggs of *T. telarius* alone in the adult stage were very short-lived. The males lived an average of 31 days and consumed an average of 79 larvae and 181 eggs each, and the females lived 41 days and consumed 110 larvae and 231 eggs each. Six of these females, which appeared almost dead, were given larvae of *B. praetiosa,* whereupon they became active and lived an average of 135 days, consuming 500 larvae and 356 eggs each in that period.

Mating took place soon after the last moult, the act taking about the same length of time for the two species. Only the females that had copulated laid eggs. The males mated readily with more than one female of the same species. Males and females of opposite species did not copulate when paired in capsules. Eggs were laid singly at irregular intervals. The average incubation period of *T. tiliae* eggs was 4.3 days and that of *T. corticis* was 3.2 days, the difference being highly significant by analysis of variance. The eggs of *T. corticis* appeared to contain fully formed larvae while still within the body of the female, whereas no similar phenomenon was observed in the eggs of *T. tiliae.*

Table II shows that the pre-oviposition period was shorter and the oviposition period longer in *T. tiliae* than in *T. corticis;* also, *T. tiliae* laid more eggs. Both species laid the most eggs when fed larvae of *B. praetiosa.* There was little difference in the duration of the oviposition period or the number of eggs laid between females of *T. corticis* fed on *B. praetiosa* larvae alone and those fed on *B. praetiosa* larvae and eggs of *T. telarius.* When this species was fed eggs of *T. telarius* alone in the adult stage the length of the oviposition period and the number of eggs laid were markedly reduced. Six of these females, mentioned previously, that were fed larvae of *B. praetiosa* after eggs of *T. telarius,* became active and laid an average of 11.7 eggs in 51 days.

Sixty-one per cent of the *T. tiliae* adults reared were females and 39 per cent were males; of *T. corticis,* 63 and 37 per cent respectively. No *T. corticis* females or *T. tiliae* males developed to adults when fed eggs of *B. praetiosa.* The numbers of individuals reared and the percentages becoming adults (in parentheses) when fed on the various types of prey were as follows:

Prey	*T. tiliae*	*T. corticis*
B. praetiosa larvae	50(84)	75(64)
" " eggs	24(8)	35(20)
T. telarius eggs	27(85)	46(0)
M. ulmi eggs	33(50)	32(25)
B. praetiosa larvae + *T. telarius* eggs	—	17(65)

TABLE II

Pre-oviposition and oviposition periods (days) and numbers of eggs laid per female in two predacious species when adults fed on various prey in the laboratory

T. tiliae			*T. corticis*		
Pre-oviposition	Oviposition period	No. eggs	Pre-oviposition period	Oviposition period	No. eggs
Bryobia praetiosa larvae					
4.5	56.7	29.3	6.3	38.4	17.8
Tetranychus telarius eggs					
7.6	70.4	11.7	—	—	—
B. praetiosa larvae and *T. telarius* eggs					
—	—	—	8.6	35.8	15.2
B. praetiosa larvae* and *T. telarius* eggs					
—	—	—	5.8	1.8	1 5
B. praetiosa eggs					
6.5	7.0	3.0	—	—	—
Metatetranychus ulmi eggs					
4.4	25.8	12.2	11.0	15.7	4.0

*In sub-adult stage.

Summary

A new species of predacious mite, *Typhlodromus corticis*, of the subfamily Phytoseiinae was found on the bark of apple trees in Nova Scotia. This species is similar in structure to *Typhlodromus tiliae* Oudms., but differs in habits. Under controlled laboratory conditions, *T. tiliae* developed and laid eggs when fed the larvae of *Bryobia praetiosa* Koch or eggs of *B. praetiosa*, *Metatetranychus ulmi* (Koch), or *Tetranychus telarius* (Linn.). *T. corticis* developed and laid eggs when fed larvae of *B. praetiosa* or eggs of *M. ulmi*. When protonymphs of *T. corticis* were fed eggs of *T. telarius* they did not develop to deutonymphs but when they were fed eggs of *T. telarius* and larvae of *B. praetiosa* the development was similar to that of those fed larvae of *B. praetiosa* alone.

Acknowledgment

I am indebted to the other officers of the Kentville laboratory and to Dr. H. H. J. Nesbitt, Carleton College, Ottawa, for advice on this paper.

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Periods of Flight and Oviposition of the Cabbage Maggot, *Hylemya brassicae* (Bouché) (Diptera: Anthomyiidae), in Southern Alberta[1]

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The cabbage maggot, *Hylemya brassicae* (Bouché), is one of the main factors limiting the production of high-quality rutabagas, *Brassica napobrassica* Mill., in the irrigated districts of southern Alberta. This crop is damaged late in its growing season; there is little damage to cruciferous crops in early spring except that occasionally early-transplanted cauliflowers are killed. This suggested the possibility of some change in the cropping practice if the flight and oviposition periods, recorded herein, were accurately known.

Methods and Materials

Emergence of adults from overwintered puparia was recorded in 1955, 1956, and 1957 from cages over portions of fields in which a cruciferous crop had been grown the previous year. In 1956, growing rutabagas were cut off at soil level on July 30 and then caged to confine flies emerging in the late summer. Cutting off the plants eliminated foliage in which flies could escape detection. The Laurentian variety of rutabaga was used in all cases.

In 1953, 1955, and 1956 eggs were collected every two days from eight, six, and six plants, respectively, of Early Snowball cauliflower. All the plants were transplanted from the greenhouse at least two weeks before examination. In 1956, a second set of six plants was transplanted on July 30 to provide young plants for oviposition sites in late summer and fall.

All records were taken at Lethbridge except adult emergence in 1955, which was recorded at Cranford, Alberta, 20 miles east of Lethbridge.

Emergence of Adults

Flies began emerging from overwintered puparia on May 18, 21, and 8 in 1955, 1956, and 1957, respectively; the peaks of emergence occurred in the latter part of May and early June and again in mid-July in 1955, in the last two weeks of May in 1956, and by May 15 in 1957. In 1956, summer generation flies, from plants that had been exposed to maggot attack until July 30, began emerging on August 10 and reached a peak of emergence in the last two weeks of August. The number of adults recorded was 55 in 1955, 67 in 1956, and 186 in 1957.

Oviposition Periods

In 1956, oviposition by the overwintered generation began on May 25, four days after the first emergence of flies, and lasted until July 2, with the peak period in the first two weeks of June. An average of 321 eggs per plant were taken. Weather conditions caused two conspicuous drops in the numbers of eggs during this period; one on June 5, 6, and 7, when the average wind speeds during the day were 38, 34, and 25 m.p.h., respectively; and the other between June 13 and 17, which was marked by cool conditions and 2.3 inches of precipitation. No eggs were found between July 4 and August 4; the generations were distinctly separated, probably as a result of the 2.5 inches of precipitation and the low temperatures from June 29 to July 4, which ended the flight more abruptly than would warm sunny weather.

The summer generation produced an average of 321, 462, and 507 eggs per plant, and lasted for a period of 78, 65, and 62 days, respectively, in 1953, 1955,

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and 1956. The peak periods of oviposition were between August 19 and September 14 in 1953, August 23 and September 19 in 1955, and August 25 and September 18 in 1956 when 74, 77, and 85 per cent, respectively, of the eggs were found. The greatest number of eggs taken from one plant for a two-day period was 160 on August 30, 1955.

Discussion

The peaks of flight and oviposition occur in May to June and again in August to September, indicating that there are two generations per year in southern Alberta. Eggs laid in late summer in 1953 and in 1955, when spring oviposition was not recorded, could only have been produced by the summer generation flies as most of the overwintered generation would have had to survive 80 days as adults to produce them. Spring flight and oviposition in Alberta is a little earlier than that found by Brittain (1927) in Nova Scotia; however, the summer generation in Alberta is a full month later and the occurrence of a third generation is unlikely.

The spring flight period was much earlier in 1957 than in 1955 or in 1956 as a result of warm weather in late April and throughout May. No explanation for the extended period of flight in 1955 at Cranford was found.

The flight records indicated that the peak of oviposition is expected in the first week of June; this coincides with the emergence of the rutabaga seedlings, which are sown late April and late May. Observations showed that small plants, in the six- to eight-leaf stage and often larger, are not attractive oviposition sites. Consequently, delaying the sowing date so that the susceptible stage for oviposition does not occur at the spring peak of egg laying should reduce the number of adults in the crop during August and September. As the Laurentian variety requires only 92 days to mature, sowing in late May should be a distinct advantage. Similarly, field-sown cabbage and cauliflower may escape attack whereas transplanted cauliflower is likely to be damaged because of its more mature condition at the time of the early flight.

Summary

There are two generations of the cabbage maggot annually in southern Alberta. Adults began emerging from overwintered puparia on May 18, 21, and 8 in 1955, 1956, and 1957, respectively; most emerged in the last two weeks of May and the first two weeks of June. Summer-generation adults emerged in late August and produced a maximum number of eggs in early September. The second-generation maggots cause the more serious damage to rutabagas.

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The Origin and Evolution of the Pupa

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There have been several speculations as to the origin and significance of the pupa. One that has had considerable vogue is based on the interpretation, by Lubbock (1883), Berlese (1913) and others, of the larva as a free-living embryo prematurely hatched before it has attained the form characteristic of the adult. A nymph, according to this theory, has completed its embryonic development in the egg where it passed through stages corresponding to those of the larva and attained the form of the adult before hatching. This concept assumes, therefore, that the pupal stage is the equivalent of all of the nymphal instars compressed into a single instar. There are many objections to this theory of which the following may be given. Development from the larva to the adult is not continuous. There is evidence that larval and adult structures are determined independently in the embryo, and the development of the one and the suppression of the other are controlled by the endocrine system. Furthermore, changes in hormone balance which take place in the last nymphal instar of the Exopterygota result in the development of the adult, while similar changes in the last larval instar of the Endopterygota bring about the development of the pupa. For this and other reasons the pupa must be regarded as an adult instar and not as a larval or nymphal instar.

Wigglesworth (1954) has maintained recently that the pupa is not to be regarded as a developing adult but "as the product of independent evolution in one form in a polymorphic organism to suit the ecological and anatomical needs of the insect in question". However, he uses the term "polymorphism" in its widest and most literal sense to include differences "between young and mature, between male and female, between forms appearing in the cold and wet seasons and those appearing in the hot season or dry, etc." On this definition practically all animals are polymorphic and the term loses any special significance.

Other theories of the pupa are based on recognition of the fact that form divergence in the larva is the result of coenogenetic adaptations distinct from those of the adult. The beginning of structural divergence may be seen in the Plecoptera, the immature stages of which are typical nymphs, resembling the adult in all respects except for the modifications which fit them for the aquatic habitat. Further divergences between nymph and adult may be found in the Ephemerida and Odonata. The Endopterygota show still wider divergencies and must undergo profound transformations in the change over from larval to imaginal instars, transformations which for the most part take place during a quiescent pupal stage. It has been claimed, therefore, that the pupal stage evolved as a device to facilitate the rapid change over from larval to adult tissues. One of these theories regards the pupa, specifically as a device to permit the evagination of the wings and other appendages, which now develop internally during the larval stage, but, as Hinton (1948) points out, it requires only one moult to evaginate the appendages. The wings of male embiids develop internally and are evaginated during the final moult without the intervention of a pupal stage. On the other hand the wings of some Coleoptera develop externally during the pharate pupal stage.

The same argument holds true for most of the internal organs. In many Exopterygota considerable changes occur in some organs during the final nymphal instar without the intervention of a pupal stage, and in the Endoptery-

gota, even when changes are profound, these with a single exception are completed during the pupal stage and do not require a pupal moult.

The one exception, as first pointed out by Poyarkoff (1914), is the skeletal muscles, especially those of the head and thorax most of which in the adult are either new or changed in their linear dimensions. Muscles must develop in a straight line between their points of attachment to the cuticle, and the distance between these points must be more or less fixed so that the muscles may be of the right length. Adult muscles can only develop, therefore, in an instar in which the distances between their attachments are the same as in the adult. This requires a pupal stage having essentially the same form as the adult, which can serve as a "mould" for the development of the imaginal muscles. The reason why a further moult is necessary lies in the fact that muscles can be attached to the cuticle only if they are formed while the cuticle is being actively secreted. Most of the imaginal muscles, however, are formed after the secretion of the pupal cuticle, hence the need for a pupal moult in order that the muscles may be attached to the imaginal cuticle.

Poyarkoff's theory of the significance of the pupa has been adopted and further elaborated by Hinton (1948). It is the most plausible theory thus far proposed, but it assumes that "whenever the difference between the larval musculature and the adult musculature reached a point where new attachments for imaginal muscles became necessary, a new moult had to intervene, and thus a pupal stage became interpolated between the larva and the imago" (Snodgrass, 1954). In other words the pupal stage evolved whenever the necessity for it arose; but the doctrine of causal necessity excludes that of physical indeterminacy, i.e., the operation of the laws of chance. It seems much more likely that natural selection would operate to prevent too wide divergence in structure between immature and mature stages.. If the structure of the immature stage diverges so widely from that of the adult that the transformation of the one into the other becomes difficult, the chances are that the species would be eliminated. The chances of a convenient mutation arising at this stage, large enough to provide a new adult form which would overcome this difficulty, are so slight as to be negligible.

The theory I am about to propose agrees with that of Poyarkoff as to the significance or function of the pupal stage but disagrees as to its origin. It assumes that the pupa is not a new form but the modified first adult instar of ancestral Endopterygota which retained an adult moult, and that the extreme form divergence of the larva was made possible largely because of the retention of this moult. In other words the pupa did not originate because of larval divergence; extreme larval divergence was possible because of the existence of a potential pupal stage.

There can be no doubt that the wingless ancestors of the Pterygota moulted during the adult stage as do recent Thysanura and other wingless arthropods. One primitive pterygote order, the Ephemerida, has retained an adult moult. Snodgrass (1954) believes this to be a "holdover by a primitive insect from wingless ancestors that shed the cuticle periodically throughout life", but he does not believe "that there can be any real relation between the imaginal moult of the mayfly and the moult of the pupa".

It is possible, however, that the Endopterygota may have descended from winged ancestors which, like the mayflies, retained an imaginal moult and had two adult instars. When the structural divergence of the larva reached the stage where new imaginal muscles could not be attached at the last larval moult.

these muscles could develop during the first adult instar and could be attached when the cuticle of the second instar was being secreted. Thus there would be the existing conditions for the attachment of imaginal muscles and there would be no need to assume the emergence of a new instar for this purpose. Dürken (*fide* Poyarkoff) has shown that a few thoracic muscles are unattached in the subimago of mayflies but become attached during the final moult. A similar condition may well have existed in ancestral Endopterygota and this would mark the beginning of the evolution of the pupal stage. The unattached muscles would be few and not essential to locomotion, therefore, the first adult instar would still be active and essentially similar to the final instar.

The possibility for the attachment of new imaginal muscles would set the immature stages free to depart more and more in form and structure from the adult as they became adapted to new habitats and new conditions of life different from those of the adult. There would be increasingly greater differences between the musculature of the larva and that of the adult, and more and more new muscles would need to be attached in the adult. There would be, therefore, a gradual loss of activity in the first adult instar resulting in its gradual evolution into a quiescent pupa.

To a limited extent this gradation can be observed in recent species as there is a tendency for the pupae of generalized species to be more active than those of more specialized species. Larvae differ from adults most widely in the head and thoracic regions, and it is in these regions that the greatest changes in musculature take place. In many species some abdominal muscles are carried over through the pupa to the adult, and the abdominal segments of the pupa are capable of some movement, even sometimes to the extent of bringing about limited locomotion. This is seen best in the pupae of aquatic Nematocera like the mosquitoes which can swim freely as the result of active abdominal movements. In muscoid Diptera all, or practically all, of the larval muscles are lost and are replaced by imaginal muscles, but at least in some species, certain abdominal muscles are not replaced until late in pupal life, and the pupa may be capable of very restricted abdominal movements.

The evolution of a quiescent pupal stage would favour the rapid transformation of other divergent organs, because nearly all of the physiological activities of the pupa can be directed to this end. This would give still more scope for structural divergencies in the larva.

This theory obviates the necessity of determining how a new instar arose as soon as it became necessary, and it explains as well as any other the possibilities for extreme divergence in form and structure between larva and adult.

Summary

Theories which regard the pupa as the final larval instar or as a compression of nymphal instars are untenable. It should be regarded instead as an adult instar. Poyarkoff's contention that the pupa serves as a "mould" for the establishment of new imaginal muscles is the only acceptable theory of the function of the pupa, but the author questions the assumption that the pupa is a new instar evolved when the divergence between larval and imaginal musculature became so great that a new moult between the last larval instar and the imago became necessary. He suggests instead that ancestral Endopterygota, like recent Ephemerida, may have had two adult instars. The first would serve for the development of adult muscles which would become attached at the final moult. As the number of these muscles increased the first adult instar would become less active and would finally evolve into a quiescent pupa. This

in turn would make possible wider divergences between larva and adult. Thus there were existing conditions for the attachment of imaginal muscles and there is no need to postulate the emergence of a new instar.

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Notes on Behaviour of *Pemphigus betae* Doane (Homoptera: Aphididae) Infected with *Entomophthora aphidis* Hoffm.[1]

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Normally the sugar-beet root aphid, *Pemphigus betae* Doane, lives and feeds on sugar-beet roots below ground during the summer and fall. However, in many beet fields between Lethbridge and Monarch, Alberta, in September, 1956, a large number of these aphids were found on the soil surface and on the

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Fig. 1. *Pemphigus betae* Doane infected with *Entomophthora aphidis* Hoffm. on beet leaves.

crowns and leaves of the plants. Many of the aphids had crawled up the plants and, even after death, remained clinging to the leaves (Fig. 1). This clinging reaction seemed similar to that of grasshoppers infected with *Entomophthora grylli* Fresen. Mr. R. B. Baird, Entomology Laboratory, Canada Department of Agriculture, Belleville, Ontario, identified the organism causing the disease destroying these aphids as *Entomophthora aphidis* Hoffm. This is the first record of this disease killing subterranean aphids in Canada. The only other reports of *E. aphidis* on root aphids are those of Maxson (1916) in Colorado and Charles (1941) in California. In Canada, it has been previously reported as a factor in control of the pea aphid, *Acyrthosiphon pisum* (Harr.), in the Annapolis Valley, Nova Scotia (MacLeod, 1953).

The importance of this disease in control of the sugar-beet root aphid is difficult to evaluate. Although it destroyed aphids in many fields in 1956, the incidence of the disease was negligible in 1957. Because all the sugar beets in Alberta are grown on irrigated land and moisture is generally considered to promote the development of fungous diseases, modifications of irrigation methods may aid in establishing this disease in the area.

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The results of the election by mail ballot for 1958 were as follows:—

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